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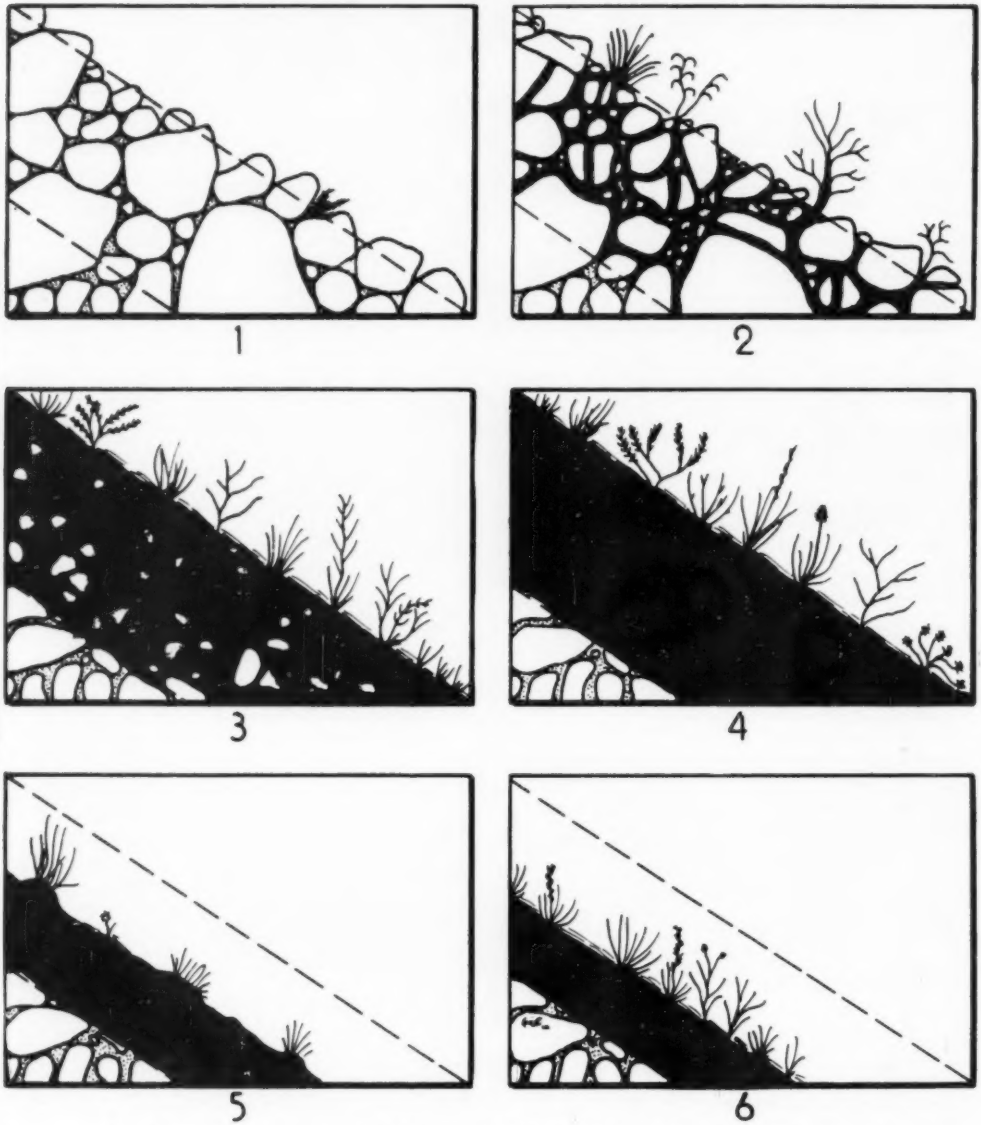

FIG. 1.—Panels 1 to 4, progressive development of soil mantle from talus rock in the course of primary succession; panel 5, the soil mantle partly stripped away by accelerated erosion; panel 6, the eroded slope subsequently stabilized by vegetation. All highly diagrammatic.

The Ecological Basis for Judging Condition and Trend on Mountain Range Land[1]

Accurate judgment of range condition and trend on mountain range land of the West is no cut-and-dried matter. This fact is highlighted by a tendency toward increasing conservatism in grazing-capacity estimates over the years, recently by many sharp disagreements between livestock operators and officials responsible for management of public lands, and, in some instances, by wide differences of opinion among range managers themselves. A better understanding of the ecology of mountain range land is needed to help reduce these differences. This paper attempts to fill this need to the extent of explaining the ecological basis of the concepts condition and trend. It is written from the experience of more than a decade of ecological research on subalpine range-watershed lands in central Utah.

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SINCE late pioneer days mountain lands of the West have been important in providing summer range for livestock. The history of most of these lands includes a period of severe overgrazing in the latter part of the past century and the early years of this one, resulting in depletion and change in the plant cover and in more or less erosion of the soil. In the past forty years deterioration has continued on many ranges. In part at least, it has continued because range managers were unable to tell how serious was the condition of these ranges, and because they believed, on insufficient evidence, that the trend was toward improvement when in fact it was not.

The range manager's problem is not an easy one. He is assigned the job of managing a piece of land which has been used and abused for from fifty to one hundred years. Ordinarily, he has little idea of what the original vegetation looked like, and hence, in many cases, little idea of the range's true potentialities. The original forage plants—at least the perennial herbs and grasses—died out years ago, and other plants have taken their place. Are they the same species? He has no way of knowing. The soil-protecting qualities of the present vegetation, its crownspread density and litter cover, may or may not be as good as that of the original vegetation; he does not know. When he sees signs of soil erosion, it may be only normal geologic erosion; it may be accelerated above normal. He does not know for sure. He sees that some plants are reproducing. Is their increase sufficiently aggressive to stop the erosion? And so on, the questions come thick and fast, compounded by variations in elevation, slope, exposure, and soil; but answers founded on fact are few.

The man assigned the management of mountain range land faces problems whose final solutions require years of scientific study, but he is expected to deliver immediate answers that are both correct and practical. With the help of a few ecological principles he must be his own scientist, and by observation ascertain what standards he can use for range in ideal condition, on a variety of sites. He must appraise the condition of each site—the character of soil erosion, vegetal cover, and plant composition in relation to the site's potentialities. Finally, he must weigh the evidences of change, to ascertain whether range trend is toward or away from the kind of plant cover and soil stability that is desired.

The purpose of this article is to help the manager of mountain range land formulate standards of satisfactory condition and develop a firmer conception of what the terms *range condition* and *range trend* mean. To accomplish this purpose certain basic ecological principles are outlined, and their application to judging condition and trend is given in the light of opportunities and practical limitations with which the land manager has to deal in assessing the facts.

The Range Complex

Any given area of range is a *complex*, or, to use the term proposed by Tansley (*7*), an *ecosystem*. It is made up of many different but closely interrelated parts—biotic, climatic, edaphic, and topographic (*4*). So closely are these components knit together in their influence upon one another that under natural, undisturbed conditions they can be said to form an integrated whole. Evidence of integration resides in the fact that the complex normally undergoes orderly successional change in which all its parts in some degree

[1]Besides members of the Intermountain Station, I am indebted to the following range-research specialists for helpful criticisms and suggestions on earlier drafts of the manuscript: R. S. Campbell, W. R. Chapline, David F. Costello, George E. Glendening, Kenneth W. Parker, L. A. Stoddart, and M. W. Talbot.

modify the others, and are in some degree modified, without any one changing disproportionately to the rest.

Primary Succession

A succession beginning on bare talus is probably the primary succession most generally applicable to sloping mountain lands. The one diagrammed in the first four panels of Figure 1 occurs on warm, dry, subalpine slopes of the Wasatch Plateau, and will be described in detail elsewhere (*3*).

In panel 1 the rock has reached an angle of repose. Small fragments broken from larger rocks by weathering and perhaps a little soil from lichen growth and wind-borne dust have accumulated in the interspaces. Where the accumulation is sufficiently near the surface, a fern or flowering plant has been able to establish itself. Often these earliest flowering plants are shrubs or trees rooted deep in the crevices. As disintegration of the rock continues and more and more soil is formed (panel 2), more plants become established and presumably hasten chemical weathering of the rock. In panel 3 the soil is no longer confined to crevices in a matrix of rock; rather, the rock is so far decomposed that its remnants lie in a matrix of soil. Soil maturity, shown in panel 4, is arbitrarily assumed to have been reached when the remnants of rock are essentially all decomposed.

The attempt is made in these diagrams to emphasize two related and important facts. First, soil and vegetation develop concurrently. Second, during the entire successional process soil is practically always under some kind of protection against surficial erosion. When the soil is scanty, occurring only in crevices, it is protected by rocks. When it appears at or near the surface it is also protected by plants, their living crowns, their litter, or both; and when rocks are no longer abundant on the surface, vegetation has the entire protective function.

How long this process takes is not known. Hundreds of years, certainly (old logs, decaying stumps, and mature trees in the intermediate stages suggest as much); possibly thousands. A well-defined soil mantle in the mountains, even though not mature as in panel 3, is something of great antiquity. From the standpoint of practical range management, this is a most important fact.

Integration and change.—A soil mantle develops, together with other elements of the complex, in an environment that is characterized by cyclic changes and seemingly erratic fluctuations. Weather is not constant; it undergoes a cyclic change within every year. Periods of years of low or high precipitation are the rule, and sudden torrential storms may interrupt periods of calm. The biota is not a constant; cyclic increases in rodents and predators, periodic infestations of insects or fungi, occur. Periodic fires are part of the natural course of events. We have no reason to believe that these fluctuating natural factors have been essentially different during the past few decades from what they have been during the past few centuries, or even, perhaps, the past few millenia. They make differences today in volume production of vegetation and in cover-effectiveness; they have always made differences. Yet soil and vegetation have grown up together on slopes so steep that the soil would fall downhill if it were not held in place by vegetation. This is what is meant when it is said that the components of the complex—plants, animals, and factors of soil, topography, and climate—are knit together in an *integrated whole*.

In normal succession a change in character of one component of the range complex is accompanied by orderly, far-reaching changes in other components. The process resembles orderly growth. Like growth, succession is change—change that is simultaneous in all parts of the organism. As an increment of change in vegetation occurs, for example, it is accompanied by increments of change in the character of soil, of animal life, of microclimate, and of microtopography. This does not mean that a change in vegetation is the cause of these other changes; it means simply that an essential balance exists, an integration of forces, so that, whatever the cause, all the changes occur together and in harmony.

Some ecologists may wish to restrict the idea of *balance* to an ideal climax state where a dynamic equilibrium exists, and it is for that reason that the term *essential balance* is used here. It is needed to direct attention to the interplay and equipoise of forces at any moment in normal succession—a fact of possibly greater significance than the fact of an infinitesimal increment of change. This point of view may be illustrated by considering a healthy child. His health bespeaks a proper balance among the organs and

tissues of his body. In a very real and important sense his health reflects an *essential* equilibrium, even though it is true that he is changing, by infinitesimal degrees, into an adult.

Soil an index of integration.—The presence of a well-developed soil mantle is evidence of successful integration between climatic and topographic factors, vegetation and animal life, over a great period of time. Soil stability in relation to vegetal cover is one of the most practicable indices of this integration.[2]

On the other hand, an erosion rate incompatible with the formation of such a soil mantle is evidence of disintegration, of relatively recent change in relationship between components of the range complex that were formerly well integrated. It is an indication that a change of drastic proportions, over and above the normal amplitude of environmental stress, has taken place. Usually this disintegration begins with such reduction of the vegetal cover as to expose the soil to destructive forces.

The concept of range as a complex of integrated parts goes beyond mutual development of vegetation and soil. It includes corresponding development of microclimate, animal life, and topography. However, in judging range condition in the light of present knowledge of indicators, we may restrict consideration to the balance between vegetation and soil.

Secondary Succession

Secondary succession is an interruption or modification that may occur at any time during primary succession when the vegetation is destroyed, in whole or in part, so that a different group of species is able to become established. The character of secondary succession is determined largely by the disturbing agent (fire, logging, or grazing), the character of seed source for reinvasion, and the extent of denudation. Compared with primary succession, secondary succession is a short-time affair, and normally becomes submerged in the primary successional process.

As defined here, secondary succession includes those changes resulting from *class overgrazing* where stability of the soil is maintained—e.g., a trend in which certain palatable herbs diminish in a stand grazed by sheep while relatively unpalatable grasses increase; or, with cattle, a trend in which grasses are largely eliminated and certain rather unpalatable herbs supplant them. It includes the invasion of thorn shrub and xeric conifers into heavily grazed grassland, and, on the other hand, the elimination of reproduction of hardwoods (e.g., aspen) by heavy grazing of livestock or big game, with the ultimate result that the overstory is eliminated. But secondary succession does not include these changes when they occur in company with accelerated erosion. This is something quite different, beyond the limits of normal integrative adjustment. It will be treated under *destructive change*.

In short, secondary succession, like primary succession is predicated upon internal adjustment and orderly change. In neither are the balance and integration of the range-watershed complex disrupted. The character of the complex may undergo change, in some instances rather marked change, but the essential wholeness of the complex remains.

Destructive Change

While secondary succession often presents management problems, a much more difficult and pressing problem is brought about as a result of accelerated erosion. If the overgrazing responsible for it were to cease after the first year—as a fire ordinarily ceases after it has consumed all the fuel available—the problem would hardly exist. What makes it a problem is that overgrazing commonly continues year after year, tending to insure denudation and a material loss of topsoil. Moreover, after much loss has taken place accelerated erosion may continue for many years, even though grazing is discontinued. Invasion of vegetation is not sufficiently aggressive on so greatly deteriorated a soil surface to cope readily with the combined forces of gravity, wind, and rain.

This condition is shown diagrammatically in the fifth panel of Figure 1. Contrasting this with the four panels illustrating soil development during the process of normal succession, we see that this state of affairs is abnormal. It is something that has never happened before, at least not for hundreds or thousands of years.

[2]Other practicable indices of integration in the range complex are geomorphic in character. They utilize accordance or discordance as the case may be, between observed and normal stream cutting and deposition, and between the character of observed and normal flood deposits (*1*).

Such complete denudation and such severe erosion must be extremely rare, if not nonexistent under natural conditions. If they did occur commonly, soil development certainly could not have proceeded so far and over such extensive areas as it has.

The simple fact is that, when accelerated erosion is taking place, soil is being destroyed. This destruction is not the reverse of normal succession, any more than wasting away with disease is the reverse of growth. Accelerated erosion is not *retrogression* in any practical sense. Retrogression means progress backward along a path that has already been trodden, but the trend followed in accelerated erosion represents a new route not comparable to the successional process of soil development.

This point is stressed to offset a fairly prevalent notion that soil development and soil erosion are counterparts, and that somehow soil can be built up by judicious management about as easily as it can be lost by mismanagement. No fallacy could be more disastrous. Accelerated erosion is, practically, an irreversible process. We can stop it, if it has not gone too far, but we cannot add an appreciable amount in our single lifetime by way of replacement for the soil that has been lost. A soil mantle can be lost in a matter of decades; to rebuild it may take thousands of years.

Range Condition

Range condition may be defined, adhering in part to a definition agreed upon at the 1944 Methods and Techniques Conference of the Forest Service (*8*), as follows:

> Range condition is range health; it is the relative position of a range with regard to a standard set up by management objectives within the practicable potentialities of the site. Satisfactory condition requires vegetation both sufficiently dense to maintain soil stability and having a considerable proportion of choice forage species. Unsatisfactory condition involves either vegetation so sparse as to permit erosion rates greater than normal, or, if sufficiently dense to prevent erosion, a preponderance of undesirable species.

Note the stipulation that range condition is to be judged in relation to potentialities of the site. One may not say that a meadow is in better condition than a hillside because it produces more forage or more effective cover. Rather, the meadow must be compared with other meadows, the hillside with other hillsides, of similar steepness, exposure, soil, etc. A corollary following from the phrase "practicable potentialities of the site" is that each site must be judged in relation to its present status in primary succession. Thus, while a talus slope may have the potentiality of becoming a soil-covered hillside some thousands of years hence, its *practicable* potentialities from the land manager's viewpoint are only those of a talus slope, and it must be judged accordingly.

This definition of range condition raises this question: For any given site, how can a person tell what the normal potential is? The most direct way is by comparison with vegetation and soil of similar sites that have never been grazed. Usable areas of this sort are no longer easy to find, even in the mountainous West, and because of this fact their value is so great that those which still exist should be preserved at all reasonable costs. Their preservation is really a great economy, in view of the information they provide which can be obtained otherwise, if at all, only at great expense and years of research effort. Lacking natural areas, the range manager can sometimes synthesize a partial conception of the normal potential by putting together scraps of evidence—remnants of soil or relic species preserved in one way or another—from parts of the grazed range in different degrees of depletion, or from invasion in artificially protected areas and on permanent plots. So detailed an approach, however, is really a research job. Even so, some acquaintance with natural areas is almost essential in reconstructing a true picture of natural conditions.

Returning to the definition, we know that range condition ceases to be satisfactory when accelerated soil erosion sets in, when destructive processes clearly exceed constructive processes. Hence a basic criterion of range condition is degree of soil erosion, and a minimal requirement for satisfactory condition is normal soil stability.

Although to determine precisely what normal erosion *is* may be difficult, even by study of natural areas, to determine what normal erosion *is not* is often easy. Inasmuch as formation of a soil mantle is an imperceptibly slow process, the process of normal erosion on any widespread scale must also be imperceptibly slow. This inference gives rise to a rough rule: "If you can see it, it's accelerated." Like all rules of thumb this one has its limitations: (1) it is applicable only under local climatic conditions that permit formation of a soil mantle—something generally true in mountain range land; (2) the evidences

of erosion must be widespread, not confined to occasional spots a few square feet, or less, in area; and (3) there must be evidence of continuance over several years. These restrictions are not so burdensome as they might seem; and the rule of the thumb is pretty generally useful on mountain range.

Finally, in addition to the prime requisite of a vegetal cover adequate to prevent accelerated erosion, the value of the vegetation as forage must be taken into account. Judgment of condition must weigh the value of present vegetation against that which might grow in its place.

There are thus two bases for judging range condition—soil stability and forage composition. The two cannot well be combined into a single term or figure; they are different kinds of things and are not additive. This difficulty is lessened somewhat by the fact that they are of very unequal weight, the latter being far less important than the former, so that the question of forage composition can be deferred until that of soil stability is evaluated. This is to say, judgment should be based primarily on soil stability, and on forage only after it is certain that vegetal cover is sufficient to preserve the soil.

Weather and Condition

Range condition is often attributed to weather or "climate." The belief finds extreme expression in the assertion that deteriorated range will be restored "if and when it rains" (*5*).

In order to evaluate this element of range condition it is necessary to make a distinction between weather and climate. Climate is an integration or summation of weather over periods to be reckoned in centuries, and perhaps millenia. Compared with weather, which may fluctuate rapidly between one extreme and another, climate is a constant. It changes so slowly—if it is changing at all—that instrumental records for the past two centuries fail to demonstrate a permanent shift (*6*). It is climate rather than weather that determines the essential nature of the range complex. The succession of plants and animals, the succession of microclimates at the soil surface, the development of soil, the evolution of land forms, is each a characteristic expression of a prevailing overall climate. The period in which these successional processes have continued is sufficiently long to include the entire amplitude of weather fluctuations characteristic of the climate. Hence what a person may consider an abnormal drought or wet spell or freeze may well be infrequent and exceptional in his personal experience, but still only part of the normal climatic pattern.

In formulating a concept of range condition we must know, at least broadly, what effects these variations in weather cause; and what, in and of themselves, they cannot cause. Certainly they cause great variations in volume of forage production from year to year. They cause great differences in species composition whenever there is a great difference between low phase and high phase in the precipitation cycle. These facts are amply documented by ecological studies during and since the latest drought period on the Great Plains.

On the other hand, variations in weather alone cannot account for the incision of a soil mantle by an active gully system; they cannot account for the cutting of torrents through an alluvial fan, carrying coarse materials beyond it. Soil mantle and alluvial fan are themselves evidence of thousands of years of slow, constructive processes under the influence of a particular climate. To attribute recent, severe erosion to prolonged drought or intense rainfall, therefore, one must postulate a recent shift in climate, sufficiently radical to undo the edaphic and geomorphic work of ages. There is no evidence of such a shift. On the contrary, there is ample reason to believe that the present climate, which has existed during the few generations since settlement, with all its extremes in weather, is essentially the same as that climate which has extended over the past few thousand years.

Thus, although variations in weather are certainly accompanied by variations in vegetation (although to a less extent in mountain climates than in the more arid lowlands), and doubtless by variations in rate of erosion, they have only a superficial, not a fundamental, bearing on range condition. Fundamentally, range condition refers to those persisting qualities of the range complex that endure throughout vicissitudes of weather, that—following Webster in definition of condition—characterize "a mode or state of being."

If condition of the range may properly be likened to health of an individual, variations due to weather are analogous to an individual's moods. An invalid may be cheerful, and at times a healthy person is depressed. A mood is hardly a valid indication of the true "mode

or state of being," and so it is with weather and range condition.

Condition on Eroded Soils

The fact has been stated that accelerated erosion has been widespread on mountain range lands of the West, particularly on herbaceous slopes. Panels 5 and 6 of Figure 1 illustrate the point diagrammatically. Although the diagrams show that about half the original soil mantle has been lost, and although some sites have lost more than half their mantle and some less, this proportion is not to be interpreted as the average loss. Nobody knows, as a matter of fact, what the average loss has been.

When soil is being lost, as in panel 5, condition is certainly unsatisfactory. But when the slope is stabilized by vegetation, as in panel 6, what then? Should condition be regarded as unsatisfactory because the soil has been deteriorated, as compared with panels 3 and 4? If this convention were to be adopted, the slope would be unsatisfactory for generations, even though it supported the maximum volume and quality of vegetation of which the site is now capable. It would appear wiser to accept the fact of deterioration, and the fact that the lost soil is water under the bridge—or, rather, mud under the bridge—and base management judgments on the "practicable potentialities of the site" as it now exists.

But for sites so deteriorated, what standards of vegetal volume and composition should be adopted? Can sites so deteriorated support a vegetal cover that will stabilize the surface as successfully as the original cover? Nobody knows. As has been pointed out, these eroded surfaces are something new under the sun, and time and study will be required to learn what their true potentialities are.

For the time being there are two estimates of what these eroded soils are likely to support when they are stabilized. One is derived from comparison with natural areas, and is probably an overestimate. The second is derived from comparison with the rest of the more or less deteriorated range, and is very likely to be an underestimate. The true value may be expected to lie somewhere between. Artificial reseeding has possibilities for revealing the true potentiality of eroded soils. These possibilities have hardly been explored as yet. For the time being, if one must err, it is certainly better to err on the side of an overestimate than an underestimate until an accurate appraisal of the true potentiality of the range can be made.

Thus as a practical expedient the natural area remains the most serviceable standard of range potential; and the rule remains valid, for present practical purposes, that visible, widespread erosion on a soil mantle is accelerated erosion. With these criteria many of the errors that have been made in the past, through underestimating what the range should look like and what it should produce, can be avoided.

Range Trend

Elaborating on the definition arrived at by the Forest Service Conference in Denver in 1944 (*8*), we may define range trend as change in the range complex from one condition to another. When sufficient vegetation grows on the range so that the soil is stable, trend may be either upward or downward depending on whether the amount and quality of vegetation is improving or declining. When the soil is unstable, trend must of practical necessity be considered downward.

Succession is involved in range trend, but in practical range management trend has little direct reference to normal, primary succession. The trends with which the range manager is mostly concerned are those involved in loss or stabilization of soil, and decline or improvement in forage value. They are mostly the brief changes that may be expected within a single lifetime. The range manager's most urgent concern is with trends toward or away from soil stability. If he can stabilize the soil, constructive trends can follow. Normal succession, including normal soil development, can proceed, although for reasons already given the progress made during the range manager's lifetime will probably be imperceptible.

Trend is measured between two points in time, usually between the present and a time in the past, either by means of some kind of permanent plot or by means of indicators such as pedestaled plants or an age-class distribution. In any case, the trend in which the range manager is most interested—What will happen in the future?—cannot be examined and measured; by projecting past trends forward it can only be inferred. The more accurately past trends can be measured, therefore, and the more nearly up-to-date they can be brought, the more accurate will predictions of future trend be.

Range trend is often difficult to evaluate, especially by inspection unaided by permanent-plot records, because quantitative measurements can seldom be used. It is easy enough, when shrubs or trees make up part of the cover, to tell whether the woody plants have been increasing or decreasing by counting growth rings and numbers of individuals of different sizes. But with herbaceous species, classification into age classes is very rough, and the age classes are bounded by loose qualitative limits—very old, mature, young, very young, for example—rather than by precise quantitative limits. Moreover, there is at present no means, capable of application on a wide scale at least, for evaluating rate of soil loss. Except when extreme changes are under observation it is practically impossible to tell whether the rate of loss has recently increased or lessened. Finally, in appraising trend, one must make allowance for merely apparent trends due to current fluctuations in weather which may obscure the true, long-time trend. This means that often a true but recent change in trend cannot be certainly known while it is still recent; time must pass before it can be verified.

These difficulties explain why disagreement as to trend is so common, and why expected trends very often do not materialize. There are too few facts to go on. Clearly, there is need for more and better permanent plots and photographs, and for increased skill in interpreting the changes they reveal. Lacking these records and this skill, we obviously need to use caution and conservatism in basing predictions upon indicators observed on the range. Unfortunately present judgment of range trend must be based almost entirely upon this imperfect record—or, at least, the record we imperfectly understand—written on the range by past events.

Trend When Soil is Stable

So long as the soil is stable the range manager dependent upon indicators can evaluate trend by the evidence he finds indicating increase or decrease of the various species in the stand. His interpretation will vary with specific objectives of management—for cattle forage certain species may be desirable that would be relatively undesirable for sheep, deer, or elk. And, aside from their relative palatability or their nutritive quality, some species may be highly regarded for their watershed protective value, or for their low consumptive loss of moisture. Again, best use of the land might call for the reproduction, or suppression of reproduction, of certain trees or shrubs. In any case, the range manager attempts to manipulate secondary succession; and indicators that tell him whether or not the stand is changing as he wishes are the age-class distributions of desirable or undesirable plants.

Trend on Eroding Soil

The question is more complicated when the soil is no longer stable. Trends in vegetation are taking place, either toward more effective cover or less, and at the same time soil is eroding. What is the net trend? This is a problem of widespread and practical urgency on many range-watershed lands (*2*).

Figure 2 is constructed to represent trend in range condition over a past time period *OB* and a future time period *BD*. At time *O*, when the white man's livestock first began to graze, the range was in virgin condition, *y*. Between time *O* and the present, the range has deteriorated through accelerated soil erosion, and the cover has been depleted by loss of desirable forage species. . At present *B*, after the range has deteriorated to a lower condition-level *z*, corrective measures are being taken.

If accelerated soil loss is stopped immediately, amount of soil will remain essentially constant as represented by the horizontal line at level *z*. Soil formation is so exceedingly slow that no measurable increase in depth of soil can be expected during the few decades *BD*. Hence the very most that can be done, so far as amount of soil is concerned, is to hold fast that which remains. Improvement, meaning to make better, is hardly a suitable term in this sense.

To stop accelerated soil loss so quickly is not

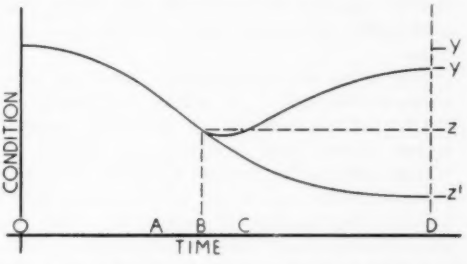

FIG. 2.—Diagram to represent various elements in range trend. *Oy* is virgin condition, *Bz* is condition today after a certain amount of deterioration, and *Dy'*, *Dz*, and *Dz'* are possible condition levels of vegetation or soil at some future time, *D*.

generally possible without artificial measures. Even if all livestock were to be taken off deteriorated range, accelerated soil loss would not stop immediately everywhere, and it might long continue on some sites. Time is required to build up an adequate protective cover of vegetation upon which soil stability depends. Hence trend in loss of soil will follow some such course as shown by line z'. Before full stability is reached some further loss of soil is inevitable.

Since rate of loss at time C (say 6 tons per acre annually) is less than at time A (say 10 tons), can it be said that improvement has taken place in the interval? Certainly deceleration of erosion represents improvement *in rate*. Yet if maintenance of full soil stability cannot be called improvement of the resource, since deepening of the soil mantle is negligible within the range manager's lifetime, how can deceleration in loss be called improvement? "To improve" means "to make better," not "to make worse at a less rapid rate."

The conclusion to be reached from this reasoning is that, so long as soil is being lost in appreciable amount, trend of the range is downward. Doubtless it is philosophically true that, as erosion is being checked, a point will be reached where the increment of vegetal gain must counter the increment of soil lost. But, practically, how is one to recognize this point? Very likely it involves a rate of accelerated erosion that is imperceptible. Doubtless, too, some rates of vegetal increase are so great that an eroding soil will be stabilized in the foreseeable future, but how can one be sure of this if he cannot measure either rate? Taking into account the difficulty of field measurement of trend, both in vegetation and soil, and the value of a soil resource which can be destroyed but not practicably restored, we reach the conclusion that, practically, soil erosion always means downward trend.

This being so, improvement can only begin where soil is stable. It will be reflected in the quality of the soil, in its structure, organic-matter content, and receptivity to rainfall. It will be reflected in amount and kind of vegetation. In either case, trend in soil quality and in amount and quality of vegetation, after soil stability is achieved, may be represented by some such line as y'. Note that this line tends to level off at a condition somewhere below the pristine level y. It fails to reach this level in time period BD because soil depth is less than that of the pristine range, and the deteriorated range now probably has a different potential than the original. This point has already been considered.

It is more difficult to determine trend than condition. This is unfortunate because the range manager, anxious for improvement, is more interested in trend. For one thing, in thinking of trend an element of prediction is involved, of looking into the future. For another, recognizable changes are not always a result of livestock management, and skill and judgment are needed to distinguish changes occurring as a result of weather, rodents, insects, game animals, etc., from those that occur as a result of grazing by livestock. The population of one plant species may be changing in one direction while an apparently equivalent species is changing in another, for no known reason; this, of course, is simply a reflection of our own lack of ecological understanding. Finally, vegetal trends and soil trends do not always parallel one another. They may be widely divergent on eroding range (*2*), and if the range manager is impressed by evidence of change in vegetation and not by evidence of soil erosion, he may be led astray. In short, trend on mountain range land is not readily describable in a word or a single phrase, and it is fair to suspect, when one encounters such an easy description, that it is an inadequate summary of the facts on the ground.

Summary

1. Because the range is a complex of closely interrelated parts normally in essential balance with one another, a standard of integrity is provided against which range condition may be judged.

2. As a result of these interrelations and because of the reactions of plants and animals on the environment, orderly change (primary succession) takes place without loss of integrity in the complex; this change is much too slow to be manipulated practically by the land manager.

3. Secondary successions result from disturbance of the complex; but by definition changes accompanying long-continued soil erosion are not considered successional. Secondary successions are much more rapid than primary successions, and are capable of being manipulated by the land manager so as to produce desired results within a reasonable time.

4. When disturbance is so extreme as to destroy integrity in the complex, as evidenced by

accelerated erosion, the term *succession*, which should imply an integrated complex, is no longer appropriate, and *destructive change* is applied in its place.

5. Range condition must be judged on the basis of the normal potential of the site. What this normal potential is can be ascertained most practicably by comparison with natural areas that have never been grazed.

6. While condition on eroded, but now stabilized, soils properly requires new standards, the best approximations now available are natural areas.

7. In judgment of range condition, soil stability is paramount in importance; forage values are secondary. Where soil is eroding, condition is unsatisfactory. Where soil is stable, condition may be satisfactory or unsatisfactory, depending on the desirableness of the vegetation in relation to the management objective.

8. Where soil is eroding at an accelerated rate, trend is downward. Improvement while soil is eroding is very nearly a logical impossibility, and, from a practical standpoint in judging range trend, should be regarded as impossible.

9. Trend where soil is stable may be either upward or downward. It is to be judged by evidence of change in vegetal composition, toward dominance either by more desirable or less desirable species, as revealed for the most part by age-class distributions.

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To Prosecute, or Not to Prosecute[1]

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"An Old Southern Custom"

THE HISTORY of forest fires on the Cumberland Plateau is similar to that of many southern states. Before the Cumberland National Forest was created, much of this heavily forested and populated area was burned over annually. Residents of Morehead, for example, say it was a common form of recreation after dark to drive out on the highways and watch the woods burn. Burning the woods in Kentucky was a custom handed down from father to son as being beneficial. They believed it would green up the woods in early spring, kill snakes and ticks, and clear out the trash. Probably this practice stemmed from fires considered essential by the early settlers for clearing new ground, and eliminating hiding places for Indians.

Such was the situation when the Cumberland National Forest was created in 1930. The first work was of course appraising values of lands and negotiating options for their purchase. Soon, however, Civilian Conservation Corps camps were established and fire control work got under way. Suppression was the first fire job. During 1933 and 1934 no record of the number or size of fires was kept. Crews were sent to any and all fires and helped suppress them. Some people thought the C.C.C. was to help farmers burn their debris—a thought heard even now at rare intervals. Construction of fire towers, telephone lines, and roads was begun, but the enforcement of fire laws was not given much thought until 1936.

The first fire prevention work was probably the use of C.C.C. patrolmen to contact local residents in 1934. Patrolmen were continued until about 1937 when they were abandoned in favor of lookouts and other local employees doing the contact job. About 1943 contact work was given exclusively to lookouts or other regular employees, and this procedure has since continued. In 1937 a movie project was set up and one man devoted full time to rural showings for a year or two. Since then movies have been shown sporadically. For six months in 1938 a psychologist lived among the local people, posing as a geologist, studying their attitudes and behavior as related to fires and to the general Forest Service program. Since 1936 most other known means of prevention have been used, such as personal contacts, posters, press releases, exhibits, leaflets, radio, and law enforcement.

Progress Has Been Made

These activities have paid off. From a peak of 1,000 fires per million acres protected in 1936, the rate of fire occurrence has dropped to 70 or 80. There has, however, been little change in the average area burned per fire in 14 years (10 to 15 acres) in spite of more humid weather in recent years. The average elapsed time from discovery to attack is about 1½ hours. Even C.C.C. did not seem to lower these averages. Area burned has fallen from 2 percent in 1936 to one-tenth of 1 percent. A summary of all fires from 1935 to 1948 inclusive shows the causes as follows:

	Number	Percent
Incendiary	717	30
Smokers	638	26
Debris burning	430	18
Miscellaneous[2]	255	10
Railroads	166	7
Campfires	111	5
Lumbering	47	2
Lightning	39	2
	2403	100

General Education

Education which was begun in 1934 by C.C.C. patrolmen, and enlarged by regular workers in later years, ran into strong adverse sentiment. Many folks were too set in their ways to stop burning the woods or too proud to admit they might have been wrong. Government interference, some called it. It was hard to prove to them how fire prevention would mean dollars in their pockets. Results in the woods seemed too slow.

Even today, when farmers are shown how to increase their tobacco income by priming (re-

[1]Condensed from a paper read at a meeting of the Kentucky-Tennessee Section of the Society of American Foresters at Cumberland Falls State Park, October 29, 1948.

[2]Miscellaneous fires are chiefly from smoking game out of trees, burning buildings or sparks therefrom, or children playing with matches.

moving the lower leaves as they ripen before the upper leaves), some are still loath to accept the idea. Education is a slow process at best. And when children are not taught these things in school, they will grow into adults faster than forestry education can reach them. If parents are unsympathetic, children are inclined to be likewise.

Hazard Reduction

Hazard reduction has accomplished a substantial lowering of fires only along a few railroads, and then only in years and sections when rights of way were well fireproofed by burning. The annual burning of sedge grass only makes the right of way more hazardous the next year. The Southern Railway is currently cooperating in an experiment whereby the right of way is mowed in the fall instead of being burned in early spring. Results have not been conclusive, but some other way than right-of-way burning must be found if the railroad fire problem is to be licked.

Law Enforcement

In 1936 a legal assistant was employed on the supervisor's staff; his duty was to promote law enforcement. Training schools were held for all regular employees and a law enforcement manual was issued. The objective was to investigate the cause of every fire and take action against offenders.

Undoubtedly the bad fire season of 1936 showed the need of a law enforcement program. With only 2 cases initiated in 1935 out of 185 fires, it is obvious that no program existed prior to 1936. In 1936, out of 71 cases initiated, there were only 20 criminal cases concluded involving 31 persons. Of these, 13 paid fines or went to jail (total of 85 days) for failure to pay fines, and 18 had fines suspended. Only 10 cases were settled by collection of damages. This left 41 cases that were to a certain extent "duds." Indictment was refused or they were dismissed after initiation. Sixteen of these 41 were turned down by prosecuting officials. By present day rules these 16 fires would not be listed as initiated. Fifty letters of warning were written to parties responsible beyond a reasonable doubt for causing fires. This practice of warning letters was continued in decreasing tempo until about 1942 when it was generally discontinued. The law enforcement figures are shown in Table 1.

Early prevention work may not have pointed up the probability of law enforcement soon to come. Every campaign to enforce a law must have advance publicity. For example, people need to know when the enforcement will begin, whether first offense penalties will be only a warning by the judge, or whether the party responsible may pay the damages without expecting criminal prosecution. All modern public relation methods need to be brought into play.

Obstacles

Forest officers in the early years faced many obstacles. In studying and overcoming them, we have established guide lines for meeting current situations and for training personnel. It was found that judges and prosecuting attorneys first had to be interested in fire prevention and forest management activities. In addition, the voters who elect these officials had to be convinced. Interested judges will usually issue warrants; sympathetic attorneys will allow witnesses to testify before grand juries; and cooperative sheriffs will serve warrants and subpoenas promptly. Informed officials will see to it that docketed cases are not dropped or dismissed, and that fines are paid and not suspended. Some judges have authority by law to suspend judgments (circuit judges in Kentucky), while others do not (county judges). When a replevin bond is given to pay a fine within a stated period, the cooperative judge will insist on its payment instead of forgetting it. A defendant will often plead poverty and a good judge will recognize that a fine or penalty within the defendant's means will insure that future

Table 1.—Law Enforcement Record, Cumberland National Forest, Kentucky

Calendar year	Actionable fires	Cases initiated	Civil	Criminal	Percent of actionable
1935	185	2	(No		1.1
1936	467	71	breakdown		15.2
1937	179	31	available)		17.3
1938	193	39			20.2
1939	210	40			19.0
1940	321	46			14.3
1941	192	64	17	47	33.3
1942	126	83	30	53	65.9
1943	99	56	28	28	56.6
1944	82	45	28	17	54.9
1945	56	28	19	9	50.0
1946	131	43	19	24	32.8
1947	89	22	14	8	24.7
1948	76	20	15	5	33.3

fires that tend to make the poor poorer will be prevented.

Many fires on the Cumberland have been caused by juveniles. Juvenile judges often cooperate with forest rangers by placing juveniles on probation for a specified period, usually in the custody of a parent. The parent is really the one responsible, but of course cannot ordinarily be prosecuted for an offense committed by the child. Judges sometimes require juveniles to erect fire prevention posters or write essays on conservation.

It is not essential that a case be won in order to accomplish good results. One example of this was a youth who (undoubtedly) set 17 or more fires along a road one afternoon. The court officials were not cooperative enough to render prompt action. As the boy was to be inducted into the armed services, the landowner and forest officer secured the warrant. When they arrested the boy, he made bond and slipped off to the recruiting center. However, the grand jury returned a true bill and the Army sent him back for trial. After the prosecutor outlined his evidence, the judge allowed a directed verdict of dismissal. There have been no fires in this area in the six years that have since elapsed.

Among the defenses that may be set up, the forest officer must be alert to offset these allegations: (a) the defendant has a job promised to him, if he is acquitted; (b) he is the only source of support for an aged and helpless mother; (c) he is feeble-minded; (d) he did not "abandon" the fire; (e) he "fit the fire" till he was exhausted. Forest officers must be alert to assure themselves that needed witnesses will be at the trial, whether summoned legally or not. If a witness refuses to be sworn or to testify, trouble is brewing; one key witness was murdered before the trial.

The principles and cautions above mentioned will be found helpful in federal court cases as well as in state courts. The United States judge and attorney (or an assistant who handles fire cases) are key individuals and should be well informed of the forest objectives. The marshal and his deputies can be of great aid in serving papers promptly.

Advance Policies

It is essential that the law enforcement policy be clearly set forth and understood by all persons who are to put it in effect. Many official employees are as reluctant to participate in legal affairs as is the average citizen today.

One of the important parts of such a policy is to decide the degree to which cases will be initiated. By that I mean, shall cases be initiated only (a) where the party responsible is willing to plead guilty, or (b) where guilt is clear beyond a reasonable doubt, or (c) where there is some question of guilt? It is desirable to have an "open and shut" plea-of-guilty case to initiate before a new judge. This allows him to become familiar with the law violated, the possible penalties, and renews his acquaintance with the investigator. After this, more and more difficult cases can be taken before the same judge with more assurance of receiving sympathetic consideration.

Even fires in group (c) above may be tried occasionally. For example, a number of fires occurred in one community without clues strong enough to be convincing. A moonshine still was found in a burned area. Although there was no proof that the still owner caused the fire, he was prosecuted for the fire and pleaded guilty—and paid the $20 fine. No fires burned in this area for six years. It was eventually learned that the defendant did not cause the fire. The example, however, provided a caution to the entire community. It may be argued that in this case the still owner was receiving a penalty for operating a still instead of causing a fire. However, the presence of the still was probably a contributing factor to the fire.

Evidence will often point to some shady character in the community. If he is prosecuted, his neighbors will say he got what was coming to him even if they know he didn't cause the fire. I say "know" because the people of a community soon learn who starts nearly every fire—grapevine information usually works. It is often impossible for an outsider to learn the facts. If an innocent though suspicious party is prosecuted, he is of course acquitted, so he pays no penalty except loss of time. Lawyer fees in such cases are small or not charged at all. The net result is that the community is impressed that the investigating agency means business. Of course, the defendant and court must be convinced that the forest officer is merely doing his duty. Often an officer can provide the defendant with transportation home and thus get better acquainted.

Some judges like to handle civil cases, but do not like to decide criminal issues. In this event,

a judge with concurrent jurisdiction elsewhere in the area may be found. This is possible in Kentucky, where magistrates have equal criminal jurisdiction with county judges.

Essentials of Enforcement Program

After an enforcement program has been started, it is essential that it be maintained at a steady and consistent level even though there is change in personnel. Too often a new ranger will undo the work of several years of steady enforcement.

It is not necessary that all forest officers be highly trained specialists in law enforcement. Give men of reasonable intelligence some training, put the administrative urge behind them, keep up sustained and persistent effort, and you have the essential elements of a successful program.

Training

In 1942, with the war getting under way, it was believed that sabotage would occur in this country. Consequently, men from important industries and utilities, as well as public employees of major resource agencies, were given training in army camps to combat sabotage. This training was conducted in a realistic manner by FBI personnel and other authorities in their respective fields. I was chosen as one of the Forest Service men to take this training. I went to Ft. Oglethorpe, Georgia, for one month, where with others I received training in such things as complaints, warrants, arrests, searches, investigational methods, various kinds of clues, sources of information, handling evidence, photography, ballistics, sabotage methods, court procedure, admissibility of evidence, and report writing.

Upon my return to the Cumberland, a three-day training meeting was held at Cumberland Falls State Park for our forest rangers and guards, foresters from nearby forests, and state forest representatives. Most of the Ft. Oglethorpe subjects were covered in abbreviated form.

This training stimulated the law enforcement work already begun in the spring of 1942 and resulted in more cases initiated and a good percentage of convictions. In the past year or two the records indicate somewhat of a letdown, traceable to two factors. First, the fires are of the more difficult type to solve. Debris-burning fires—usually easy to solve—have just about disappeared. The bulk of the fires are now caused by hunters, smokers, and incendiaries—all tough ones. Secondly, it has been difficult to maintain an administrative urge. The war is over, emergency measures are not popular, and the timber sales activity is at a peak.

If the number of fires continues to stay below or close to 100 per year, it can safely be said that the fire occurrence objective is being met. It is not denied that weather has been on the damp side in recent years. However, one cannot travel in any part of the forest without being informed by local residents that fires are rare because "folks is a-skeered to let fires get away." (And I say "rare" because the risk on the Cumberland is tremendous. Thousands of people are in the woods much of the time.) Further questioning will usually bring forth the definite claim that the "woods is growing up a lot greener than it used to."

Qualifications

There is a wide variation in aptitude and desire among forest administrators when faced with law enforcement. Some simply do not like to appear in court; others take to it naturally. Many of the characteristics of a good investigator are also qualities that make for general success in life. For example:

1. A righteous indignation against wrong doing.
2. Common sense, good judgment, and tact.
3. Aggressiveness and persistence.
4. Resourcefulness.
5. Thoroughness.
6. Ability to observe and good memory.
7. Technical skill and knowledge of the "modus operandi."
8. Familiarity with local customs, dialects, topography, and the people themselves—for example, who lives where.
9. Ability to write a good report.

Forestry Schools Can Help

It is not entirely the fault of unit managers that their law enforcement records are sometimes pitifully poor. The "powers that be" often turn thumbs down on legal action for fear of stirring up trouble, political, or otherwise. Perhaps just as important is the fact that foresters receive little, if any, law enforcement training in college in preparing them for the first major test of their professional career in fire control. I cannot agree that this is entirely an on-the-job training subject. All forestry

schools should include somewhere in their curricula at least the following subjects:

1. Qualities of good investigators.
2. Methods of investigation (observation and description, interrogation, surveillances, undercover work, and entrapment).
3. Laws and statutes.
4. Equipment used.
5. Clues—footprints, tire tracks, tool marks (especially axes), fingerprints, firearms—exploded shells, etc.
6. Marking, handling, and preserving evidence (for example, making plaster casts).
7. Complaints, warrants, arrests, bonds, summons.
8. Trial procedure.
9. Evidence in court (admissibility, witnesses, what must be proved).
10. Report writing.

It may be argued that it is the prosecuting attorney's duty to handle many of these details, and indeed it is. An investigator is likely to find, however, that an attorney who has not been fully informed and convinced of the need for forest protection is likely to be on the defendant's side.

Special Cases

Perhaps some examples of the application of science to fire problems will emphasize my points. A bee tree was cut in Rockcastle County and axe chips were on the ground. The ranger visited nearby residents, checked chips at woodpiles, tried axes, and soon found chips that matched. Although the case was not initiated in court for various reasons, few fires have since occurred in that area. The owner of the axe maintained his innocence, but everyone in that community knew who got that honey.

Another typical case matched axe chip marks. The owner of the axe at first denied all knowledge of the affair, but soon admitted that two boys had borrowed his axe to cut down a chestnut tree to smoke out a squirrel. The boys confessed and paid up.

To compare axe marks properly, chips should be taken from similar wood species and before the axe has been sharpened. Also chips must be taken with right and left hand swings, and with both edges if the axe has a double bit. Every dent or gash in the edge of the blade will be visible on the top of the chip if so held that the light throws shadows across the lines.

Federal Bureau of Investigation

Occasionally, unusual clues will be uncovered. An alert ranger, searching carefully, found a lock of singed hair caught on the root of a stump inside a burned area. Horse tracks led to a nearby farmhouse, where an animal that made similar tracks was found. The owner admitted riding through the area but denied causing the fire. The ranger obtained a lock of the suspect's hair. Both locks were sent to the F.B.I. laboratory, which replied that they were similar in every major respect. Confronted with this evidence, the suspect admitted he had been drinking and had fallen off his horse, which ran home. He had then lighted a fire to warm himself; and, when it scorched him, he jumped up, bumped his head on the stump, and left without extinguishing the blaze. He paid a fine in county court.

The laboratory facilities of the F.B.I. are available to give expert information on all types of evidence. If requested, the F.B.I. will furnish an affidavit. In important cases, the bureau will send an expert to testify at the trial, though ordinarily it prefers to assist in field investigations only in incendiary cases and when federal property is burned or threatened.

Plaster Casts

One technique every investigator should know is how to make plaster casts. These are valuable in cases involving footprints or tire tracks. Ordinary plaster of Paris, obtainable from a dentist or at a drugstore, is sifted slowly into cool water until a thick cream is produced when stirred. This is poured carefully into the print and reinforced with sticks. It sets in about ten minutes. It can be removed and when further dried, gently washed clear of dirt, reveals the print in detail.

Not far from Cumberland Falls tracks of two persons were found near several burned buildings, whence a fire had spread to the woods. Casts were made which later matched those of two suspects. There had been previous feuding in the vicinity. These parties were brought to trial in state court, but due to technicalities it was lost. But there have been no more fires in that area.

Bloodhounds

In the previous case a bloodhound was used to locate the persons who made the tracks. The Cumberland bought two bloodhounds in 1941.

One was half foxhound, but could trail as well as the other. In any area where a concerted major effort must be made to curtail incendiarism, a bloodhound will pay for itself. Although easily handled, a dog requires considerable exercising.

Investigation First

In an area where numerous small fires are the rule, I believe it is wise to send an investigator either before or with the suppression crew. A crew usually destroys what few clues may have been left by the person who caused the fire; a few acres are saved, but the causative agent goes unpunished and more fires occur. If a choice existed, it might be better to begin a law enforcement program a year in advance of a suppression organization. This might stimulate local residents to organize really volunteer crews with only nominal outside help, thus avoiding "job" fires.

Conclusion

It is not the writer's intent to state or imply that law enforcement without other means of prevention will solve an area's fire problem. But it is contended that every case well handled—and by that I mean thoroughly and tactfully investigated and prosecuted—will in the long run help reduce the number of forest fires, regardless of whether the case is won or lost.

The Bible says in Exodus 22:6: "If fire break out, and catch in thorns, so that the stacks of corn, or the standing corn, or the field, be consumed therewith, he that kindleth the fire shall surely make restitution."

Weather and Outbreaks of the Fusiform Rust of Southern Pines

Fusiform rust of southern pines attacks slash and loblolly pines seriously and at all stages. Weather conditions in late winter and early spring influence the yearly prevalence of the disease in pine tree nurseries. By studying temperature records nurserymen could predict the relative infection-hazard by the end of March. Thereafter, moisture relations mainly influence the amount of pine infection. Knowledge of the influence of weather on incidence of infection would help in effectively controlling this disease in nurseries.

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THE FUSIFORM rust of southern pines caused by *Cronartium fusiforme* (Arth. & Kern) Hedgc. & Hunt, is prevalent in coastal states in the Southeast and is often serious on slash (*Pinus caribaea* Morel.) and loblolly pine (*P. taeda* L.). It attains its greatest prevalence and importance in the southern parts of the Gulf States east of the Mississippi River (*2*), where it has been studied continuously since 1937 (*1*). A general summary by Siggers and Lindgren (*5, 6*) gave the status of the investigation through 1947. Siggers (*4*) in reporting a study of the temperature requirements for germination of spores of *C. fusiforme* found that conditions favorable to abundant infection of pines are a minimum of 18 hours, with temperatures between 60° and 79° F., and humidity maintained close to the moisture saturation point. This paper deals with the influence of weather on yearly prevalence of infection, particularly with reference to the widespread outbreak on slash pine nursery seedlings in 1938. Variation in amount of infection between different localities in the same season, due to site conditions, is not considered herein.

The fusiform rust seriously affects nursery production of slash and loblolly pine. In some years in some nurseries it has rendered 50 percent of the slash pine stock unfit for planting; the culling of 3 million rust-infected seedlings in one nursery in one year is a matter of record, yet the disease may be largely prevented by spraying (*3*). To be of maximum effectiveness, spray treatments can be regulated by a knowledge of the effect of weather on the incidence of rust infection. It will be shown later that temperature records may be used to estimate the probable infection-hazard in early spring and that sprays may be so timed as to attain maximum effectiveness in rust control with minimum cost.

Life History Influenced by Weather

The organism causing the fusiform rust of southern pines lives on two kinds of hosts. One stage affects the woody parts of pines, chiefly slash, loblolly, and longleaf pine (*Pinus palustris* Mill.); the other stage develops on the lower side of leaves of oaks, mainly species of the pointed-leaf or black oak group. On pines, the rust is perennial and damaging; on oaks, it is annual and of little importance. There is always enough inoculum (aeciospores) from pine in late winter to start infection on the first oak leaves. The infection on the oaks first produces spores, called urediospores, which may infect other oak leaves and thus serves to build up the infection. These urediospores, however, cannot start new infections on pine and the uredial stage lasts a relatively short time. Uredia have been observed to appear and disappear on leaves of the same oak trees in 18 days in some years, and in 28 days in others. Shortly after the uredial stage appears, numerous brownish, hairlike structures, called telia, start to grow from around the base of each uredial fruiting body. These telia, in turn, produce another type of spore, the sporidia, which under suitable weather conditions infect pine, not oak. If it were not for early development of telia in spring, there would be much less potential inoculum produced capable of infecting pine.[2] Since the

[1] In the preparation of this paper the writer has drawn freely upon unpublished phenological observations and office reports by Howard Lamb and Bailey Sleeth, formerly assistant conservationist and assistant pathologist, C.C.C. respectively of this Division. Some of the collections of oak leaves were made by R. M. Lindgren and A. F. Verrall, pathologists, of this Division. Weather records, in the main, came from *Climatological Data* published by the U. S. Weather Bureau.

[2] Under certain conditions a short cycle condition is indicated. In nature telia of *C. fusiforme* appear on a tree 2 or 3 days after the first uredia and inoculations of oak leaves with aeciospores commonly result directly in telia (*4*).

aeciospores, produced on pines, and the urediospores, produced on oaks, cannot infect hard mature oak leaves, the intensity of infection on the oaks depends on a race in development between the pathogen and oak foliage. Yet for the disease to become epidemic on pines, a considerable amount of inoculum must first be formed early in the season on oaks.

The period for peak production of telia comes a few days after the passing of the uredial stage and occurs in coastal Mississippi counties from April 15 to the first week in May, depending on the season. Pines usually start seasonal growth in mid-April. Telial columns continue to grow for several weeks, though some of the older telia fall off by the last of May. Germination tests of teliospores in June showed a progressive decrease from week to week in amount and viability of sporidia obtained. It will be recalled that sporidia are the spores able to cause infection of pines. Sporidia obtained in July failed to germinate and no sporidia were formed in tests in August and September. Maximum sporidial production and pine infection come in April or May, depending on temperature and moisture relations earlier in the season. March, April, and May cover the time when rust sporulation is most active.

Prevalence in Nurseries, 1937-40

The fusiform rust surveys by Lamb (*1*) and by Sleeth in pine tree nurseries during 1937-1940 gave basic data (Table 1) for this study. Using yearly differences in the prevalence of infection at the same nursery as a criterion for the seasonal infection-hazard, one would assume that the season of 1938 would have the greatest infection-hazard, then 1939, 1940, and 1937. It was anticipated, from similar studies by other investigators, that the amount of pine infection could be correlated with yearly variations in the weather of late winter and spring.

Winter and Spring Weather

In 1937, January and May were warmer than the Mississippi 50-year average for those months, the mean monthly temperature in January being appreciably higher than that of March, which was an unusually cold month. Average temperature in February and April varied slightly from the normal. Cold weather in March probably delayed maximum sporidial production until May, a warm dry month.

The first quarter of 1938 was unusually warm in the Southeast. The February mean temperature for Mississippi was 56.1° F., 6.6° above the average. March mean temperature was 64.7° F., compared to 57.0° F., the average mean temperature. The April mean temperature, 64.3° F., was lower than that of the preceding month. Abnormally cool weather prevailed throughout the first 10-day period in April. The monthly mean precipitation was slightly above normal in March and much above normal in April. Essentially the same conditions prevailed in Alabama and Georgia. Exceptionally warm weather in late winter followed by a cool wet April produced favorable conditions for an epidemic of the rust.

The first three months of 1939 were warmer in Mississippi, Alabama, and Georgia than the average for those months. April was cold and May had slightly deficient temperature. Rainfall was somewhat deficient in March and April and above normal for May. The prevailing weather conditions favored pine infection.

Midwinter of 1940 brought unprecedented cold to Mississippi and monthly mean temperatures from March to May were colder than the average for the last 53 years. Monthly mean precipitation was deficient in January, March, and May and above average in April. Cold weather from January through May delayed development of the rust and its hosts. Seedling loss caused by the disease in southern pine nurseries was about a third of that in 1939 (*3*).

Effect of Climatic Variations

Since the start of systematic observations on the seasonal occurrence of infection by the southern fusiform rust, weather in 1938 appears to have been most favorable for infection of pine. The outstanding climatic condition in 1938 was the usually warm, region-wide weather that con-

TABLE 1.—FUSIFORM RUST INFECTION ON SLASH PINE SEEDLINGS IN SOUTHERN PINE NURSERIES FROM 1937 TO 1940

Nursery location	1937	1938	1939	1940
	Per-cent	*Per-cent*	*Per-cent*	*Per-cent*
1. South Mississippi	4.5	19.1	15.0	11.5
2. South Mississippi	5.7	16.7	...	...
3. South Mississippi	...	...	7.2	6.3
4. Southwest Central Ala.	3.8	20.8	7.0	...
5. South Central Alabama	...	...	...	trace
6. Central Alabama	...	19.0	1.0	...
7. Southwest Georgia	2.0	11.8	6.0	5.0
8. Southwest Georgia	0.8	6.0	5.6	trace

tinued from late winter through March and periods of prolonged high humidity in April. A warm February induced an early break in winter dormancy. By February 18, leaves of black jack oak (*Quercus marilandica* Muench.), near Rio, La., were an inch long and aeciospores from pine cankers near Bogalusa, La., were being disseminated. Spring foliage on water oak (*Q. nigra* L.), in Florida was well developed, as demonstrated by collections of young uredia and telia of the rust on February 20 and 21, near Brooksville.[3]

Relatively warm weather in March brought the following comment from the Weather Bureau for Mississippi: "Under the stimulating influence of relatively warm weather and of frequent showers, vegetation made unusually rapid progress and was advanced much beyond the average seasonal development at the end of the month." In the absence of observations on pine needle development it is reasonable to assume that pine foliage also was well developed.

With this unusually early development of oak foliage in 1938, undoubtedly a large amount of inoculum was being formed. The following observations concerning the effect of March temperatures, expressed as a monthly mean, on the build up of rust inoculum were made from 1941 to 1947. Leaves were collected from the same water and willow oak (*Q. phellos* L.) trees over a period of seven years, which made it possible to approximate the time of appearance, the duration, and the relative abundance of uredia and telia on those trees.

Table 2 shows the record that was obtained in the relatively warm spring of 1945 from eleven 10-leaf collections from each tree, while Table 3 gives a 6-year record of the monthly average number of fruiting bodies that were found on leaves of the water oak. When the time of appearance of the first uredia was plotted against March temperatures at Weather Bureau stations in Biloxi or Pearlington, Miss., it was found that a mean of less than 60° F., in 1941, 1942, 1943, and 1947, delayed fruiting until April 7 or 9. On the other hand, in 1945, when March temperature was 67.8° F., the first uredia were found March 14 (Table 2). With intermediate temperatures, 61.5° and 63° F., in 1944 and 1946, the first uredia appeared about March 22 and 27, respectively. The mean temperature in March 1938 was 70.2° F. In the absence of factual data, the foregoing observations suggest that an unprecedented development of inoculum took place during that year. Furthermore, cool weather and general rains after oak leaves were well developed and infected in April 1938 extended the period of leaf susceptibility and of the uredial stage.

Since urediospores may germinate in dew in less than an hour, the time-moisture requirements for germination and infection are low and would hardly limit production of these spores. Temperature in late winter and in March particularly, by stimulating early development of oak leaves in warm seasons and retarding growth in cold ones, appears to govern quantity production of urediospores. Although urediospores cannot infect pine, each uredial fruiting body gives rise to numerous telial columns which bear spores that can infect pine. The early appearance, wide distribution, and quantity production of uredial fruiting bodies are antecedent conditions for widespread epidemics of the fusiform rust on pine.

Moisture relations, however, become increasingly important in the infection of pines by sporidia. From a study of the germination of teliospores and sporidia of the fusiform rust in damp chambers, the writer (*4*) concluded that the conditions favorable to sporidial production and abundant pine infection are a minimum of 18 hours, with temperatures between 60° and 79° F., and humidity maintained close to the moisture saturation point. In this connection, York and Snell (*8*) infected seedlings of *Pinus strobus* L. with sporidia of *Cronartium ribicola*

TABLE 2.—DEVELOPMENT OF THE FRUITING STAGES OF *Cronartium fusiforme* IN 1945 ON LEAVES OF TWO OAKS NEAR PEARLINGTON, MISS.

Date of leaf collection	Fruiting bodies per leaf on:			
	Water oak		Willow oak	
	Uredia	Telia	Uredia	Telia
1945	*Number*[1]	*Number*[1]	*Number*[1]	Number[1]
March 14	0.2	.0	.0	.0
March 21	3.8	0.2	6.1	0.7
March 24	7.4	2.2	5.8	5.3
March 28	3.1	9.2	3.1	12.1
April 2	1.1	119.0	.5	50.0
April 7	.0	195.0	.0	37.0
April 13	.0	160.0	.0	71.0
April 21	.0	353.0	.0	73.0
April 28	.0	349.0	.0	48.0
May 10	.0	183.0	.0	83.0
May 29	.0	237.0	.0	42.0

[1]Based on the average number of fruiting bodies found on 10-leaf samples from each oak tree. After April 13, the number of fruiting bodies was prorated per leaf from counts on half the area of each leaf.

[3]Collections by G. G. Hedgcock, F.P. 80904 and F.P. 80907.

Fischer and concluded that at least 18½ hours of suitable weather are needed for development of sporidia and the infection of nearby pines.

April 1938 brought cool weather and abundant rainfall. Rain occurred during three periods of general precipitation; of these, the first was concurrent with rains that started March 28. Relatively low temperatures combined with several extended periods of sustained high humidity furnished ideal conditions for infection of pines. In May there were 4 periods favorable for pine infection recorded in northern Harrison County, Miss. Yet, by that time, it was excessively warm and rainfall was decidedly deficient in the southern half of the state. The peak period of pine infection undoubtedly occurred in April.

The normal climatic changes occurring in spring in the lower Gulf region east of the Mississippi River and excluding the Florida peninsula would affect the overall prevalence of the disease. March is usually the coldest spring month, often too cold for development of oak foliage. It is also the wettest month, while May is the warmest and driest. March and April are characterized by periods of general precipitation that often continue for several days. As spring advances the character of precipitation changes. May rains occur mainly in the form of local thunder showers. June brings warmer weather and days when the minimum temperature is close to the upper limit for germination of teliospores (78° F.). Theoretically, the "normal" climate in the lower Gulf states, the region where the disease is most prevalent, appears unfavorable for regional epidemics of the fusiform rust. In nature the bulk of rust infection, except in areas where local site conditions induce spread of the disease, appears to be confined to certain years when unusual climatic conditions favor production, dissemination, and germination of inoculum.

Weather and Disease Control

Relatively warm weather in late winter and March coupled with the usual ample rainfall in early spring stimulates vegetative development, so that both pines and oaks tend to break dormancy early. Aeciospores from cankers on pine start the cycle of infection on new oak leaves. Oak infection develops rapidly and abundant urediospores inoculum is formed, especially when the average temperature in March exceeds 60° F. Such combinations of weather and plant development usually indicate the possibility of much new infection on pines, especially if weather sequence brings several periods with temperatures fluctuating between 60° and 79° F. and humidity maintained close to the moisture saturation point for 18 hours or more.

Knowledge of weather conditions that induce buildup of the infection on oaks would make it feasible for nurserymen to use temperature records to estimate the relative infection-hazard, as of early spring. The mean monthly temperatures needed for such predictions would be based on the average of the daily maximum and minimum temperatures (7, p. 690) for February and March. The departure from normal for these months and the locality would be calculated from the average monthly mean temperature of record at the nearest Weather Bureau station. Likewise, annual observations on (1) the time that sporulation begins on pine cankers, (2) the general development of oak foliage, and (3) the relative abundance of the uredial stage, could be used to estimate the rust-infection-hazard in early spring.

TABLE 3.—SIX-YEAR RECORD OF THE SEASONAL DEVELOPMENT OF THE FRUITING STAGES OF *Cronartium fusiforme* ON LEAVES OF A WATER OAK NEAR PEARLINGTON, MISS. DATA REPRESENT MONTHLY AVERAGE NUMBER OF FRUITING BODIES

Year[1]	Number of 10-leaf samples collected in:			Fruiting bodies per leaf					
				Uredia collected in:			Telia collected in:		
	March	April	May	March	April	May	March	April	May
				Number	*Number*	*Number*	*Number*	*Number*	*Number*
1941	0	8	5		0.8	.0	—	87.6	284.0
1942	0	4	3	—	1.5	.0	—	11.0	91.0
1944	3	4	4	0.6	0.4	.0	0.2	25.0	22.0
1945	4	5	2	3.6	0.2	.0	2.9	235.0	210.0
1946	1	1	1	1.2	2.8	.0	.0	3.2	83.0
1947	1[2]	2	2	0.0	5.0	.0	.0	8.7	149.0

[1]Data obtained in 1943 were insufficient to be included.
[2]Leaves collected in March were too young to show infection.

Fungicidal control of the southern fusiform rust in nurseries will be most economical and effective (1) if spraying is deferred until the first yellowish spots, the uredial stage, appear on the leaves of oak trees in the vicinity of the nursery; (2) if deferred when the daily average temperature is not in excess of 56° F., the lower limit for germination of sporidia (*4*), and (3) if timed so as to precede periods of general precipitation or high humidity. If timed properly sprays containing adhesives, now readily obtainable on the market, will remain effective even though washed by subsequent rains.

Summary

Study of weather data from 1937 to 1940 and in other years indicated that warm weather in late winter and particularly in March induced favorable conditions for buildup of the uredial stage of the southern fusiform rust on oaks. Exceptionally warm weather in the Southeast in February and March 1938, followed by cool damp weather in April, resulted in serious outbreaks of the disease in pine tree nurseries. Losses in nurseries were least in 1937, when unusually cold weather in March undoubtedly delayed peak production of sporidia until May, a warm dry month.

Temperature, in late winter and March, by retarding the development of oak leaves when cold weather prevailed and stimulating growth in warm seasons, appeared to govern quantity production of urediospores. There was little, if any, evidence that variations in rainfall in the first quarter of a year influenced the seasonal advent or prevalence of these spores.

The results of this study suggest that nurserymen responsible for large-scale production of slash and loblolly pines, if aided by simple meteorological equipment and Weather Bureau temperature records, could predict the relative infection-hazard by the latter part of March. Thereafter, moisture relations determine in the main the amount of pine infection. Spraying to control the disease would be accomplished most effectively if treatments are (1) deferred until the fruiting stages of the rust first appear on leaves of oaks in the vicinity of the nursery or (2) deferred when daily average temperatures are not above 56° F., or (3) timed so as to precede periods of general precipitation or of high humidity.

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[4] A change that was made to the title of this paper by the publishers involved the anomalous use of *Cronartium* Fr. in a specific sense for *Cronartium fusiforme*.

Erosion from Melting Snow on Frozen Ground[1]

Erosion caused by snow melting on frozen ground on western mountain slopes has been given little attention. The authors present some observations to show that it is of considerable importance.

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SUMMER STORMS of cloudburst intensity have caused local areas of accelerated erosion in northern Utah. Other erosive forces also contribute to the overall erosional activity, although they operate less spectacularly than do the destructive mud-rock flows from summer storms. Indeed, widespread erosion over large watersheds and the localized occurrence of summer storms are difficult to reconcile without recognizing other agents of erosion.

During February 1949, investigations through the Spanish Fork watershed near Provo, Utah, and the Weber River watershed near Ogden were made to observe the effects of erosion from melting snow on previously frozen soil. The relations between this type of erosion and vegetation and land use were also studied. The heavy snow cover and unprecedented cold wave during the winter of 1948-1949 presented an unusual opportunity to do so. As part of the study, a number of steep slopes eroded by melting snow were photographed for future reference and comparison. In addition, soil samples were collected for laboratory analysis.

On the steep slopes facing south and west most of the snow had melted by the end of February. In these places there was widespread erosion from the combined effects of snow melt, frozen ground, steep slopes, and poor vegetal cover. Mile after mile of disturbed slopes showed a pattern of fresh rill erosion with soil and rocks deposited on alluvial fans or along highways (Fig. 1). Perhaps the most spectacular view was presented along sheep driveways where the horizontal trails had become interwoven with vertical patterns of rill erosion.

Erosional Activity

One type of erosion was the mass movement of saturated but frost-free surface soil over frozen soil and snow (Fig. 2). In this case the ground had been frozen to a depth of about six inches and the sun and snow water thawed the top few inches of soil. When the surface mantle became saturated, no water could escape into the relatively dry soil below the frost layer; neither could the water seep downslope fast enough to drain the surface. As a result a mass of mud would break loose, gain momentum on the steep part of a slope, and finally come to rest on the flatter part which formed a zone of deposition for the debris. Each slide left in its wake a gully down to the frozen layer.

Another type of erosion was caused by the free water released by snow melt. It worked its way over and through the inch or two of thawed mantle and collected to form rivulets. These small fingers of water traveled downhill, picking up soil particles in proportion to the volume of water or speed of flow. The sediment load was deposited farther down the slope at a point where the water could drain from the flow and be absorbed by the surface material. This intermittent process caused a pattern of rill erosion with zones of sediment deposition at the base similar to miniature mudflows.

At the end of February frozen ground was still present under all active slides which were then at about 7,000 feet on southwestern exposure. Eroded areas at lower elevations had for the most part thawed throughout the mantle except for freezing of the surface during cold nights. This alternate freezing and thawing did not appear to reactivate the slides after the snowbanks ceased feeding water into the saturated soil. It is probable that a long hard winter greatly increases the erosional process since, at high elevations, frozen soil was found wherever the depth of snow was less than about 18 inches.

Southwest exposures with an average slope of 70 percent were generally severely eroded. Slopes of about 50 percent showed occasional gullies. Erosion was more prevalent on shallow clay soils overlying shale formations. A high clay content in the frost zones of the soil profile was associated with the formation of miniature mudflows, although slides were seen on a few sand and gravel banks.

[1]The authors are indebted to O. C. Olson and W. E. Murray for soil moisture and other observations.

FIG. 1.—A typical southwestern exposure on a 70 percent slope, showing rill erosion and debris deposition from melting snow and frost action in sparse herbaceous cover. Spanish Fork Canyon near Provo, Utah.

FIG. 2.—Close-up at top of erosion area in Figure 1, showing soil movement through sparse bunchgrass.

FIG. 3.—Severe rill erosion upon steep slopes lacking soil-binding vegetation. Soldier Creek Canyon near Thistle, Utah.

FIG. 4.—Small mudflow that traveled through sparse sagebrush on a 50 percent slope to zone of deposition on snowbank. Weber Canyon near Devil's Slide, Utah.

Effect of Vegetation on Erosion

Most of these observations of eroded slopes were made on open rangelands with a cover of grass and weeds or sagebrush; some were also made on oakbrush sites. Vegetation was sparse on clay hills. Furthermore, livestock had severely trailed most of the slopes (Fig. 3), and deer also congregated on them when the snow became less than in the surrounding mountains.

Mudflows generally originated where the vegetation was in a depleted condition. Small clumps of grass could not stop flows (Fig. 2), and open sagebrush was not effective in checking them (Fig. 4). Clumps of oakbrush could stop a small flow, and steep slopes covered with dense brush were not found to be eroding. No comparable slope with dense grass cover was found, since accessible slopes were usually barren either naturally or from abuse. The contrast between lack of erosion in herbaceous vegetation and its presence in a bare spot immediately below is shown in Figure 5.

FIG. 5.—Rill erosion cutting through exposed soil; notice the lack of erosion above in the better vegetation. Weber Canyon near Ogden, Utah.

Soil Moisture

Samples from active mud flows at 6,500 to 7,000 feet elevation down a 65 percent slope of a raw spoil bank at Wasatch Summit averaged about 33 percent moisture based on oven-dry weights. This moisture content is greater than the saturation point for sandy loam soils similar in texture to the mudflow samples. A sample from frozen loam beneath snow drifts also contained 33 percent moisture.

Samples cut from the frozen layer 1 to 4 inches below the surface of a clay hill at Soldier Summit showed 40 to 46 percent moisture or near saturation for clay loam to clay soils. Clay and shale beneath the 3-inch frozen layer contained only 15 percent moisture.

Near Thistle at elevations as low as 4,500 to 5,000 feet, the slide areas had dried out until only 14 to 17 percent moisture remained in the sandy to gravelly loam soil horizon that had been exposed by a 2-inch mudflow about a week before the observation.

Conclusions

1. Melting snow above frost-penetrated soil on steep, sparsely vegetated slopes causes erosion from miniature mudflows on southwest exposures.

2. Although much topsoil is being moved, there are no excessive flows of water or sediment into main streams because mudflows on frozen soil will move with very little excess water from snow banks and because alluvial fans and roadways are stopping sediment. This erosion is merely a process of removal and redeposition of soil material farther down the slope; however, debris may be carried to streams by future storms or spring runoff in subsequent years.

3. Slopes as steep as 50 to 70 percent will erode from snow melt and frost action where vegetation is sparse. Overgrazing or trailing by livestock and excessive deer use are contributing factors in depletion of the vegetal cover.

4. Brush-covered slopes are generally resistant to miniature mudflow erosion. Sparse sagebrush and grass are susceptible to this type of erosion.

The Vegetative Propagation of a Few Species of Elm[1]

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SOME ELMS can be propagated by softwood leafy stem cuttings taken in late spring or early summer. The results of earlier investigators of the subject have already been summarized and the reader is referred to the earlier publication[2] for the original sources.

Cuttings of *Ulmus pumila* L., Siberian elm, rooted in four weeks if made of new shoots when they were four to six inches long, and they rooted in largest percentages if the basal cut was made a half inch above the base of the new growth. Their rooting was improved or hastened by treatment with indolebutyric acid. Cuttings of this species and of Chinese elm, *Ulmus parvifolia* Jacq., rooted well in sand when taken in June. Cuttings of *Ulmus americana* L., the American or white elm, taken in early June, rooted well (94 percent), after treatment with indolebutyric acid 50 mg./l., 24 hours, but they rooted poorly without treatment.

Softwood stem-cuttings of *Ulmus japonica* (Rehd.) Sarg., Japanese elm, made with the basal cut at the base of the new growth, were taken in Amherst, Mass., June 4, 1948, treated with a root-inducing substance, and set in sand in a greenhouse bench. The bench was shaded on the south by white curtains on sunny days and the greenhouse is equipped with an automatic humidifying unit.

The percentages which rooted are recorded in Table 1. There was no rooting of the untreated cuttings, and cuttings without treatment all lost their leaves while treated cuttings retained theirs.

The most rapid rooting, the largest percentage of rooting (89.3 percent), and the best young root systems were of cuttings treated with indolebutyric acid 100 mg./l., 4 hours. But indolebutyric acid 50 mg./l., 24 hours, or Hormodin No. 2 also gave good results.

Rooted cuttings of Japanese elm were immediately transplanted to pots of sandy loam. As is shown in Figure 1, they made good top or shoot growth, 2 to 5 inches within sixty days after their insertion in the rooting medium. Cuttings were allowed to retain only 2 or 3 leaves when made, but when they were photographed 60 days later they bore 6 or 7 leaves and the new shoots were still growing.

The vegetative propagation of the Buisman variety of *Ulmus carpinifolia* Gleditsch (hereafter referred to as the Buisman elm) is of especial interest or importance because of the resistance of this variety to the Dutch elm disease caused by *Ceratostomella ulmi* (Schwarz) Buisman.[3]

Softwood cuttings of the Buisman elm were taken in 1948 on May 27, on June 17, and again on July 13. They were made of the new growth and allowed to retain 2 to 4 leaves, but the softest part of the terminal growth was removed. They were given the same care as were the cuttings of Japanese elm previously described.

All these softwood cuttings of the Buisman elm died unrooted. Death occurred whether the rooting medium was sand or sand-peat, and whether or not they were treated. The treatments included indolebutyric acid 50 mg./l., 20 hours; 75 mg./l., 20 hours; 100 mg./l., 4 hours; Hormodin No. 1; Hormodin No. 2; and indolebutyric acid 100 mg./l., 4 hours followed by supplementary powder-dip treatment with Hormodin No. 2.

Fortunately the Buisman elm can be propagated by root-cuttings. Root-cuttings, 3 to 5 inches in length and one-fourth to five-eighths inch in diameter, were first made on December

[1]Massachusetts Agricultural Experiment Station contribution no. 688.

[2]Doran, William L. The propagation of some trees and shrubs by cuttings. Mass. Agric. Expt. Sta. Bul. 382, 56 pp. 1941.

[3]Buisman, Christine. De resistente Iep Nr. 24. Tijdschr. Nederland. Heidimaatsch. 48:73-76. 1936.

TABLE 1.—PERCENTAGE OF SOFTWOOD CUTTINGS OF JAPANESE ELM WHICH ROOTED

Treatments of cuttings	Cuttings rooted In 28 days	Cuttings rooted In 59 days
	Percent	*Percent*
Untreated	0.0	0.0
Indolebutyric acid 50 mg./l., 24 hours	60.7	78.6
Indolebutyric acid 100 mg./l., 4 hours	82.1	89.3
Hormodin No. 1	32.1	57.1
Hormodin No. 2	67.9	78.6

5, 1947.[4] The distal ends of some of them (see Table 2) were treated with a root-inducing substance. All were covered with the rooting medium, sand or sand-sedge peat, 3:1, in a greenhouse bench for 42 days. At the end of that time the upper or proximal ends, about one-half inch in length, were bared and allowed to remain exposed to the light.

Root-cuttings were transplanted to pots of sandy soil as soon as they had made top growth, by which time they had made some new root growths also. The first root-cuttings made top growth within 45 days. The last were transplanted 167 days after their insertion, and by that time all root-cuttings which had failed to make top growth were dead. Results at that time, after 167 days, are recorded in Table 2.

The best results, wherein 53 percent of the root-cuttings made shoot and root growth, were with root-cuttings treated with indolebutyric acid 50 mg./l., 22 hours, and set in sand. But untreated root-cuttings in sand (see below) might have done as well and the treatments did not appear to have any important effects on growth.

Root-cuttings of the Buisman elm were next made on March 22. In this case, none was treated with root-inducing substances; all were planted in sand in a greenhouse bench.

[4]Dr. Curtis May, principal pathologist, Division of Forest Pathology, U. S. Department of Agriculture, supplied the material from which root cuttings of this elm were made. The writers gratefully acknowledge his cooperation.

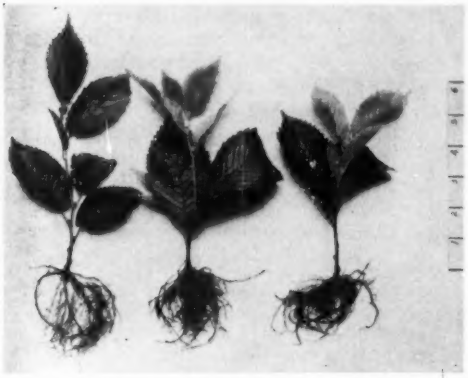

FIG. 1.—Rooted softwood cuttings of Japanese elm (*Ulmus japonica*) photographed 60 days after the cuttings were made.

FIG. 2—Buisman elm, a variety of *Ulmus carpinifolia*, grown from a root-cutting inserted in the rooting medium on March 22 with the proximal end exposed. This photograph was taken 92 days later.

Upshall[5] found that root-cuttings of apple made better root and shoot growth if planted with their tops projecting above the surface of the rooting medium. To learn whether or not that is also true of this elm, root-cuttings in one lot were so inserted in the sand that about one-half inch of the upper or proximal end remained exposed to the light and air. Root-cuttings in another lot were wholly covered, with the proximal end under about one-half inch of sand. Results 92 days later were summarized in Table 3.

These plants were transplanted to sandy loam in pots as soon as they made top and root growth. A typical root-cutting and an average plant grown from a root-cutting made in March and inserted in the rooting-medium with the proximal end exposed is shown in Figure 2.

As may be seen by reference to Table 3, 97.5 percent of these March root-cuttings lived and made good top growth, an average of 10 inches in 92 days, if the root-cuttings were inserted with the proximal ends exposed. Results were much inferior and growth was much slower if the root-cuttings were wholly covered with the rooting medium.

When the results presented in Tables 2 and 3 are compared, it is evident that March root-cuttings of the Buisman elm planted with the proximal ends exposed did much better than the December cuttings. The root-cuttings made in March made about twice as much shoot growth in 92 days as the December root-cuttings did in 167 days.

It is concluded that the Japanese elm, like the American elm and some Asiatic elms, can be propagated by softwood stem cuttings taken in June and treated with indolebutyric acid. This method was unsuccessful with the Buisman elm but that elm, it is concluded, can readily be propagated by root-cuttings taken in March and inserted untreated with the proximal ends projecting above the surface of the rooting medium.

This work with root-cuttings of the Buisman elm was done in a greenhouse, but it is quite possible that at that time of year, early spring, this elm could also be propagated in the field.

[5]Upshall, W. H. Propagation response from root cuttings planted with the proximal end projecting above the medium. Sci. Agric. 17:3:146-147. 1936.

TABLE 2.—RESULTS WITH ROOT-CUTTINGS OF BUISMAN ELM MADE DECEMBER 5

Rooting media and treatment of cuttings	Cuttings which made shoot and root growth	Average length of new shoots
	Percent	*Inches*
Untreated, sand-peat	34	4.7
Hormodin No. 3, sand-peat	38	5.0
Indolebutyric acid 50 mg./l., 22 hours, sand	53	4.7
Indolebutyric acid 100 mg./l., 22 hours, sand	48	4.0
Hormodin No. 2, sand	35	4.1

TABLE 3.—RESULTS WITH ROOT-CUTTINGS OF BUISMAN ELM MADE MARCH 22

Manner of planting of root-cuttings in rooting medium	Cuttings which made shoot and root growth	Average length of new shoots
	Percent	*Inches*
Cuttings wholly covered	17.5	2.5
Proximal ends of cuttings exposed	97.5	10.0

A Prospective View of Forest-Tree Breeding in Wisconsin[1]

The author first analyzes in general terms the need for research in forest-tree genetics, and the difficulties which the tree breeder must face. He presents a prospective forest-tree breeding program for Wisconsin. This plan includes (1) improvement of the genetic quality of the seed which is now being used, (2) selection of superior trees by testing clonal and seed progeny, and (3) building improved strains by augmentive breeding.

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IT SHOULD be helpful in projecting a forest-tree breeding program for Wisconsin to review briefly at the outset some of the general considerations underlying such a proposal. Forest-tree breeding, although not new, is not widely practiced, and has yet to demonstrate its broad usefulness. One may fairly say, therefore, that willingness to support and to undertake the work rests more upon recognition of the need for improvement in the genetic quality of planting stock, and the significant achievements attending similar efforts in agricultural plant breeding, than upon any direct assurance which can be given now that the venture will be productive of results important for forestry. This statement is not intended to cast doubt on the wisdom of exploring the possibilities of forest-tree breeding, but is a frank admission of the fact that enough unknowns are involved to warrant caution against building our hopes too high.

Since breeding is still a comparatively undeveloped segment of forestry research we may advantageously reconnoiter the field before considering ways of exploring it in detail. My approach to the problem is essentially that of a geneticist whose practical experience has been in agriculture. Naturally this fact influences my outlook, but it is hoped that it does not disqualify me altogether from making a few observations. What aspects of forest-tree breeding, in its wider relationships, impress an outsider so conditioned on running his eye over the field? The points it is desired to make are summarized below as five propositions or premises.

Five Premises

1. Let us take a quick glance at the bearing of forest-tree breeding on our general land economy. It has been estimated that approximately 16 million acres, or roughly half the land in Wisconsin, should be devoted permanently to forestry. Most of this area is in the northern part of the state. With some exceptions the region is not now well stocked with desirable trees, nor is it in the process of becoming so by natural means. This part of our woodland represents the potential for reforestation by artificial means. There are perhaps two million acres which could now be planted advantageously. Large additional areas not at present in suitable condition for planting will probably present themselves for artificial restocking in the future.

The agricultural plant breeder has contributed richly to the production resources of Wisconsin farm crop land. Full realization of a desirable land use pattern for the state as a whole demands comparable effort by the forest-tree breeder.

2. The second premise is that the reasons which may be given for improving the genetic quality of field crop plants are equally valid for nursery-grown forest crop plants. A general intensification and specialization in production and management methods are implied in the change from self-perpetuating to plantation forestry. Just as a highly developed agriculture calls for superior varieties so an advancing forest economy demands the best attainable in genetic values.

Individuality, in the biological sense of the word, assumes an importance in plantation forestry which it does not possess in the natural forest. In the latter the individual is subordinated to the population to an extraordinary degree. A totalitarian society prevails in which the mass ruthlessly holds sway over its members. The outcome for the single tree is largely predicated on the manner in which numerous external factors happen to impinge upon it. Opportunity for expression of differences in *inherent* potentiality of most of the individuals is rigorously minimized.

In the plantation, on the other hand, the pop-

[1]Paper from the Department of Genetics, College of Agriculture, University of Wisconsin, No. 390. Adapted from a talk given December 13, 1948, before the Madison chapter of the Society of American Foresters.

ulation relaxes its tight grip on the individual. Individuality now emerges as a major element in determining the gross character of the population. We commit to each individual in a plantation the utilization of a unit area of land for a long time. Whatever the level of opportunity for development the general site may offer, the relative extent to which the possibilities of this local area are realized depends upon the genetic endowment of the particular individual occupying it.

3. Under a plantation system trees must be bred for different conditions than prevail in the natural forest. The circumstances of growth are altered from the nursery stage onward through a greater or lesser part of the duration of the plantation. Possibly not since the Ice Age has the plant environment of northern Wisconsin undergone such a sudden and radical change as that caused by lumbering, extensive fires, and the subsequent spread of agriculture. Adaptation to man-made conditions now becomes a primary consideration in restocking the area with trees. One of the broad problems with which the breeder must contend is the extent to which the genotype of climatically suited forest-tree species must be reconstructed to fit the new habitat. The breeder may well find that in the selection of foundation breeding stock superior performance in a plantation may be a definitely better criterion of genetic worth than a corresponding degree of excellence in a tree occurring in a natural forest.

4. A further premise is recognition of the necessity for much specialized research in this field. Forest-tree breeding is still in its youth. Only a beginning has been made in acquiring the body of knowledge which is needed to predict the attainable goals and to devise effective ways of working toward the most promising practical objectives. A half-century of genetics research has established a solid general foundation on which to build. Only a start has been made in framing a superstructure adapted to the particular requirements of forest-tree improvement. The agricultural plant breeder can aid in the design. But there is need for discrimination in the acceptance of his ideas and procedures. He must be rigorously cross-examined to determine what part of his testimony is significant under the special conditions of forestry. It would be foolish, of course, to ignore the extensive experience which has been accumulated in developing field and horticultural crop plants; but it would be little wiser for the forest-tree breeder to assume that he can borrow all he needs from this context. Forest-tree breeding poses many problems which are unique either in kind or in the conditions under which they must be solved. So far as this is true plans to attack them must be devised on an *ad hoc* basis. Research must be directed specifically toward gaining insight into forest-tree breeding problems as such. There are a multitude of such problems which challenge the breeder, relating to reproductive behavior, the bases and distribution in populations of desirable genetic values, vegetative multiplication, and the like. Forest-tree breeding can grow soundly only as it validates its particular principles, develops its special procedures, and extends its own perspectives, through research.

5. My last premise is that the tree breeder must prepare for the unforeseen. The nature of his material dictates this paradoxical precaution. Tree species descend in slow time through the generations. Economic change, in contrast, proceeds at a headlong pace. The direction of change cannot be foretold, so rapidly does the outlook shift. As one writer has put it, "The future, like everything else, is no longer quite what it used to be."

For example, the forest is still subject periodically to catastrophic damage from new insect and fungous pests whose advent is made the more likely by the acceleration of world travel. Will these pests strike down the improved trees which geneticists develop? Will changes in utilization practice mean that tree breeders will find they have invested their research on the wrong species, or developed wood properties and growth characteristics that no longer command a premium?

Such unforeseen circumstances will not alter the geneticists broad objective—better trees. They will affect his methodology, and will require that it be flexible enough to permit adaption to circumstances which will surely change. The forest-tree breeder must admit the factor of the unforeseen into his consciousness, absorb it into his thinking, and establish it as one of the guiding principles in making plans. He must prepare for a contest in which the rules may change as the game progresses.

Forest-Tree Breeding Plans

We may turn now to a consideration of the form which a forest-tree breeding program for Wisconsin might take. The suggestions presented

at this stage are tentative and, hence, subject to revision as firm decisions must be made. Furthermore, all researchers are aware of the metamorphosis which plans often undergo between the incubative and maturation stages of a project as the initially least understood elements in the case are progressively clarified by experiment. It is taken for granted that all agree that making plans is but the prelude to an upstream swim in accomplishing them.

The policy is well established in research of reporting publicly only as integral parts of a project are brought to successful completion. The wisdom of this policy as a general procedure is beyond question. There are circumstances, however, in which exceptions are justifiable. Forest-tree breeding appears to be one of them. In this field plans as such should be scrutinized broadly even as they are being formulated. Once a given course of action is entered upon, a relatively long-time commitment of personnel and facilities is made. The start, therefore, is crucial. The breeder can best improve the occasion by seeking counsel wherever it may be had. The principal reason for setting forth some definite proposals now is that they may thereby be subject to criticism at a time when constructive amendments can be most helpful.

Where are we now, where should we strive to go, and by what means, with reference to improving the genetic quality of Wisconsin forest-tree planting stock? There is no blueprint from which answers to the latter two questions can be read. Our task is to construct one. It was the object of the forepart of the paper to establish certain coordinates. We may now sketch in a few lines to indicate the outline of an operating plan.

The proposals set forth have been drafted with the intention of applying them initially to red pine (*Pinus resinosa*) and jack pine (*P. banksiana*), now widely used in the state in artificial planting. Eventually other species, including some of the hardwoods, should be included in the program. The suggestions fall under three main headings:

1. Improving the genetic quality of the seed which is now being used.
2. Selection of superior trees by testing clonal and seed progeny.
3. Building improved strains by augmentive breeding.

These are not alternative approaches to the general objective. All are needed and should be started as soon as feasible. They differ, however, in the length of time probably required to secure results which may be carried over advantageously to forestry practice.

Improving Genetic Quality of Seed

What may be done to improve the genetic quality of planting stock in the near future? A step may be taken which in my judgment is genetically desirable; namely, the conversion of some of the best available red and jack pine forests of suitable age to seed orchards. The establishment of such seed orchards has often been advocated. Indeed, to a geneticist it appears to be the next logical step after effect has been given, as in Wisconsin, to a policy of using seed from adapted climatic races only. The object of such a plan is to make more effective use of seed sources already at hand.

The establishment of such seed orchards would involve several steps including (1) an inventory of stands of known seed origin, suitable age, and satisfactorily isolated from inferior trees of the same species; (2) acquisition by the state of the selected areas if necessary to insure preservation and continued use of the trees for seed production; (3) roguing to the best individuals; (4) application of management practices designed to favor abundant cone bearing; and (5) inauguration of a system of seed grades reflecting genetic quality and thus differentiating seed orchard stocks from those in which no information concerning the mother trees is available.

To what extent would the superiority of the seed trees thus selected be repeated in the offspring? A definite answer to this question cannot be given in advance of actual performance tests of the offspring. The suggested procedure, however, justifies adoption as a working plan both on theoretical grounds and by analogy with the extensive experience gained in this field with agricultural plants. It is potentially capable of yielding a significant, even though limited, gain.

The improvement made is likely to be relatively small because appearance alone of the parent individual is known to be of restricted value in predicting the character of the offspring. This, of course, is just what would be expected to the extent that the parental differences are of environmental origin. But variation arising from the action of environmental factors, although frequently large, is only part of the picture. The correlation in performance

between parent trees and progeny would be further lowered by the segregation and recombination occurring at the time of germ cell formation. Great variability is generated in the offspring by the reunion at fertilization of the diverse products of the assorting process, even of superior individuals. One generation of selection by this method, therefore, may be expected to shift average quality of the stock only slightly above that of the population from which the parents came. Far from realizing in the progeny the full superiority of the mother trees, it would be found that only a small part of it had been captured.

Actually, however, the case for the development of a seed procurement program of the type indicated is better than appears from the above reasoning. This statement rests upon the likelihood that under present methods the seed collected is below the average in genetic quality of that being produced by existent populations.

The system of collecting pine seed now in operation undoubtedly involves some negative selection in terms of tree quality. Seed collectors compensated for cones on a per bushel basis naturally favor trees on which the crop is abundant and readily accessible. This means that the cones are often taken from spreading, heavily branched individuals which sometimes are unthrifty growers also. The effect is dysgenic in greater or lesser degree, and dangerous if persisted in. A pronounced deterioration in the genetic quality of planting stock eventually would ensue from the practice.

To such gains over the average of the population at large as would result from using the best trees in the best stands as seed sources must be added, therefore, the improvement in genetic quality resulting from arrest of the dysgenic element in current collecting procedure. Even though, in the absence of direct experimental evidence, one is forced to argue it on general grounds, the case for rationalization of forest-tree seed procurement thus appears to be clear. Corresponding measures have long since been adopted in the production and distribution of agricultural seeds. Farmers have a well developed consciousness of hereditary values, and the seed industry is organized to supply them with stocks of assured genetic quality.

Selection of Superior Seed Trees

Progeny testing is an indispensable tool in almost any plan of constructive breeding. What has been said above will have made it clear that appearance of the individual alone is not an adequate guide to breeding worth. The genetic make-up of the plant, however, is disclosed by the character of its offspring. Only by examination of the latter can one estimate satisfactorily the quality of the inheritance being transmitted. Progeny tests take a variety of forms, depending upon the material and the objectives in view. All have the common purpose, however, of analyzing an individual's genetic complex by scoring samples of it in the offspring. Adequate progeny tests are usually laborious and costly. But there are few circumstances in which one can dispense with the information they provide. This is probably as true in the breeding of forest trees as of agricultural plants.

The manner in which progeny testing may be applied in improving the genetic quality of forest trees may be illustrated by an example. Suppose it is desired to attempt to develop a rapidly growing strain of jack pine of better form than the general run. As foundation material, cone-bearing trees judged desirable on the basis of a predetermined set of criteria would be sought out in populations of even age such as would be found in a plantation. (Of course, the establishment of suitable criteria for scoring the trees is a problem in itself, but it will have to be passed over for the present.) Let it be assumed that about two percent of the trees in the populations examined are considered sufficiently superior to the rest to warrant a progeny test. One would then gather open-pollinated seed from these trees individually and after growing out the seedlings by families in a nursery, establish suitably replicated plantations in which a comparison of the several progenies could be made with each other and with a random sample of the general population in which the foundation trees were selected. Time does not permit a discussion of the details involved in these operations, including the steps to be taken to insure as best one can against the variety of hazards to be run. Open-pollinated seed is used for the progeny tests. This is not merely a matter of convenience. It is preferred in view of the ultimate objective in mind. The purpose of the progeny tests is the discovery of individual trees possessing what the geneticist terms high "general combining ability." By this is meant an inherent capacity of the genotype to give superior offspring when crossed with various other genotypes. This can best be measured if

the seed tree under test is pollinated by a random sample of pollen from many different trees around it. Such a progeny test is called a polycross.

Parallel with setting up the seed progeny tests, graft plantations should be established for the growing of clones representing the originally selected trees. The object is two-fold. First, adequately replicated tests of the clones distributed over the area in which seed from them might eventually be used would greatly increase the precision with which the phenotype of the parent tree could be evaluated. Plant breeders, even when thoroughly familiar with material through long experience in handling it, seldom attain high accuracy in recognizing *in situ* the best individuals scattered throughout a massed planting. Supplementary tests are often required in order to complete the preliminary scoring. Replication of the individual by propagating it vegetatively serves not only to offset the effects of local environment on development of the parent tree, but also enables the breeder to judge individuality much more accurately than where he is presented with a single specimen crowded among many others differing from it in varying degrees. One would expect that the gain in efficiency in choosing superior phenotypes of forest trees would be large if, to the observations made on the individual in its original position, were added performance data on even a moderate number of suitably tested clonal offspring.

As noted below, the second important function which the graft plantations would ultimately serve is as seed orchards in which the élite clones would inter-pollinate. These special plantations would lend themselves well to intensive management methods—wide spacing of trees, pruning to a spreading form, close control of pests, and the like—which would both increase seed yields and reduce harvesting costs.

Eventually the graft plantations and seed progeny test plantations will reach a stage permitting definitive comparisons between the several clones and families. The expected outcome of such a test would be that many families would be mediocre, some rather uniformly poor, and a few definitely superior. The latter would represent the particular individuals among the two percent of trees originally selected having high general combining ability. The number of families rated superior, of course, will depend upon the standards of excellence used in judging them.

Having identified by means of the clonal and seed progeny tests the particular parent trees which have demonstrated superior transmitting ability, the plantation containing the vegetatively propagated representatives of all the original trees may then be rogued down to the élite clones. It would then become a seed orchard. The clones remaining in it will have been proved as superior parents.

Augmentive Breeding

The development of strains of forest trees characterized by particular genetic qualities which are rare (or even absent) in otherwise desirable native populations calls for special experimental procedures. Operations of this class may be termed augmentive breeding, although the expression is not entirely satisfactory. Included here may be resistance to major diseases, tolerance or resistance to destructive insects, adaptability to particular soil conditions, unusual rapidity of growth, and the like. Often a principal requisite for achieving such objectives is the development of methods by which populations may be brought under strong selection pressures for the character in question. Particularly is this true if the frequency of genes conditioning the desired quality is low in the general population, as Dr. A. J. Riker and his associates have found to be the case with resistance to blister rust in *Pinus strobus*. By rigorous selection also the breeder may be enabled occasionally to discover a major gene which confers an important advantage upon its possessor. By incorporating such a gene in an otherwise desirable stock a superior strain may then be built. Agricultural plant breeding is replete with examples of this sort.

Controlled hybridization at the species, strain, and genotype levels, as possible means both of augmenting growth rate and securing combinations of characters otherwise difficult of attainment, should not be overlooked. As knowledge of the genetics of natural populations has grown, the role of heterosis as a source of developmental efficiency has become increasingly clear. The discovery of practical ways of exploiting the vigor of hybridity, in whatever classes of matings it is strongly expressed, may justifiably be considered one of the important research areas in forest-tree breeding.

One cannot expect, of course, to exploit genetic values in forest trees as exhaustively as in

species with a short life cycle. Some of the paths which agricultural breeders have followed to profitable ends, when measured in plant generations, are far too long for the forest-tree breeder to consider exploring. This fact has too often been used as an excuse for ignoring forest-tree breeding altogether. Let us admit that a pattern of genetic operations must be evolved which is specially adapted to this area and, furthermore, that the choices of method open to the tree breeder may prove to be rather narrow. One ventures the opinion that, in spite of this restriction, the expense of systematically developing the possibilities which exist will be small relative to the cost of doing nothing about them. Some of the recent achievements in agricultural plant breeding have been extraordinarily impressive. Perhaps it will be unavoidable, but certainly it will not be realistic, to measure the progress in forest-tree breeding against them. Forest-tree breeding has a rationale of its own.

A Genetical Arboretum

An important consideration in starting a new program of research is the establishment of a broad basis for continuing progress. This calls for a long view in forest-tree breeding. We should try to anticipate what materials the geneticist will require over the decades and take the initial steps now to provide them. An evident need in this connection is the building up in Wisconsin of a comprehensive collection of the forest-tree species of known or prospective value to the region. Limited decentralization of the collection would be advisable in conformity with the soil and climatic variations in the state and the fire hazard. Inclusiveness in terms of genetic diversity within each species, not merely of "types" in the usual botanical sense, should be the guiding principle in assembling stocks. One may envisage the collection as eventually comprising representatives of the principal races of (1) the forest-tree species native to the state, (2) closely related species occurring elsewhere, and (3) exotic species which might be adapted through breeding to Wisconsin forestry.

More might be gained by such a development than accessibility to a wide variety of breeding stocks, important as this gain could be. There is need also to conserve existent genetic values in the face of the manifold shrinkage here and abroad of the native forest. The cost of maintaining a considerable number of races within an important forest-tree species would be small compared with the expense of reassembling from diverse sources the particular constellation of genes characterizing a single highly desirable strain which had been lost either by extermination or genetic impoverishment. In so far as the extermination of a race involves the extinction of genes unique to the stock, the loss is irreparable. Genes once gone, practically speaking, are gone forever. They cannot be regenerated to order.

Vegetative Propagation Research

The importance of building a forest-tree breeding program in depth through intensive research on basic problems has been mentioned earlier. Vegetative propagation is one such problem of paramount significance to the breeder. Everyone who has been concerned with the genetic improvement of forest trees has become keenly aware of the handicap under which he labors because individuals of exceptional merit in growth rate, form, disease resistance, or other characters frequently cannot be mass propagated vegetatively except at considerable expense. Vast new possibilities in capitalizing upon superior genetic values would be opened up if low cost methods of increasing clones were developed. This fact has been widely recognized, and much work in the field has been done. Even though the results with several economically important forest-tree species have not been especially encouraging, the potential gains are so great that new leads should be sought and those which look promising followed out exhaustively.

A Short Cut for Scaling Aerial Photos

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AERIAL PHOTOS are a handy tool for the forester. They furnish forest data quickly. But when the photo is used as a map, care is necessary—especially in rough country. In flat country photo scales are quite uniform and distances can be measured accurately. But in rough country photo scale varies with changes in elevation, and it is more difficult to measure distances accurately. There are other factors that affect photo scale, but land elevation is the most important to foresters.

In flood-control survey and forest survey work at the Northeastern Forest Experiment Station thousands of aerial photos are used. Frequently we need to know the scale of an aerial photo so we can measure distances or interpret some forest condition. Computing scale and adjusting it to different elevations for each photo is a tedious job. A satisfactory short cut was needed.

To fill this need we developed a method for determining the scale for any point on any individual photo of a photo project. The scale determined by this method will usually be within 3 to 5 percent of the true scale, regardless of the amount of rough land. For most uses of aerial photos in forestry this error is acceptable. In practice this method has proved to be very efficient, reliable within the limits indicated above, and easy to apply.

The Problem

In scaling distances from aerial photographs, there are two factors to be considered: (1) the aerial photograph and (2) the ground surface it represents. Getting accurate ground measurements is not a problem; the U. S. Geological Survey's topographic maps have proved quite satisfactory. The variable factor is the photograph.

If the photographic plane could fly at a uniform elevation and perfectly level while making the photographs, the problem would be simple. If it were making photographs of level ground, every photograph would have exactly the same scale.

Unfortunately, this degree of perfection has not yet been attained. Good plane crews can fly at nearly uniform altitudes under proper weather conditions. They can keep the plane nearly level, thus keeping camera tilt to a minimum; 90 percent of the photos should be affected by tilt of less than 3 degrees. The photographic equipment—precision cameras, special high-quality films—is near perfection.

However, the imperfections in flying and equipment do result in variations in the finished aerial photographs. These variations have an effect on the scale of the photographs.

As already mentioned, the elevation of the land has the most important effect on the scale of aerial photographs (Fig. 1). High land is naturally closer to the plane and camera than low land, and a photograph of high land will not have the same scale as a photograph of low land.

For these reasons, it is necessary to compute scale for the aerial photographs in order to get accurate results in measuring or studying the land surface and objects on it.

A Short-Cut Solution

One way to solve the problem would be to determine the scale for each individual photograph. However, in an aerial photo project, such as the photographing of half a dozen large counties in New York, there may be 10,000 photos, or more. Scaling each one would give complete accuracy, but it would be a long and tedious job.

Such a tedious job is not necessary. By scaling about 10 photos, selected at random, you can compute the average scale at sea level for the entire project. From this average scale you can make adjustments for different elevations.

The steps in this short-cut method are as follows:

1. Select about 10 photos at random from the photo project.

2. On each photo select two points that can be located on a base map. (Frequently, in forest areas, there is little choice in selecting these points simply because good points are hard to find on the photo. If there is a choice, look for points about the same distance from the center

of the photo, 3 to 5 inches apart, and located so that a line drawn between them would pass near the photo center.)

3. Measure the distance between these two points on both the photo and the base map.

4. Convert the base map distance to actual ground distance.

5. From the base map, determine the average elevation of the two points.

6. Compute the flying height (above sea level) of the plane for each photo. (Use Formula II.)

7. Compute the scale at sea level datum for each photo. (Use Formula I.)

8. Compute the average scale at sea level for the 10 photos.

Use this average for all the photos of the photo project. This average scale is for sea level. For other elevations you must make adjustments. This can be done simply and quickly by means of a graph (Fig. 2).

An example of the data used in computing the average scale for a photo project is given in Table 1. The 9 sample photos used in this computation yielded a satisfactory average scale.

Accuracy of Method

By taking 9 or 10 samples, you get an average scale that is merely an estimate of what the real average is. The more samples you take, the more accurate your estimate will be. For the example given in Table 1, a statistical analysis shows that the "standard error" for the average scale based on nine samples is 1.03 percent. In other words, average scales computed from nine samples are within 1.03 percent of being accurate, two times out of three; and they may be much closer to accuracy than 1.03 percent.

The average scale found for the 9 sample photos in the sample was 1:22,023. The average scale for all the photos in the project is somewhere between 1:21,342 and 1:22,704.

For other photo projects the average scales determined had standard errors ranging from 0.49 to 2.45 percent (Table 2). The amounts of scale variation by photo projects are shown in Table 2 in the column *Coefficient of variation*. Small coefficients reflect low variation. Low variation reflects better photography. Therefore, it seems that of the projects listed in Table 2, the best photography was in the GSM project, and the poorest was in the Cooperstown area project.

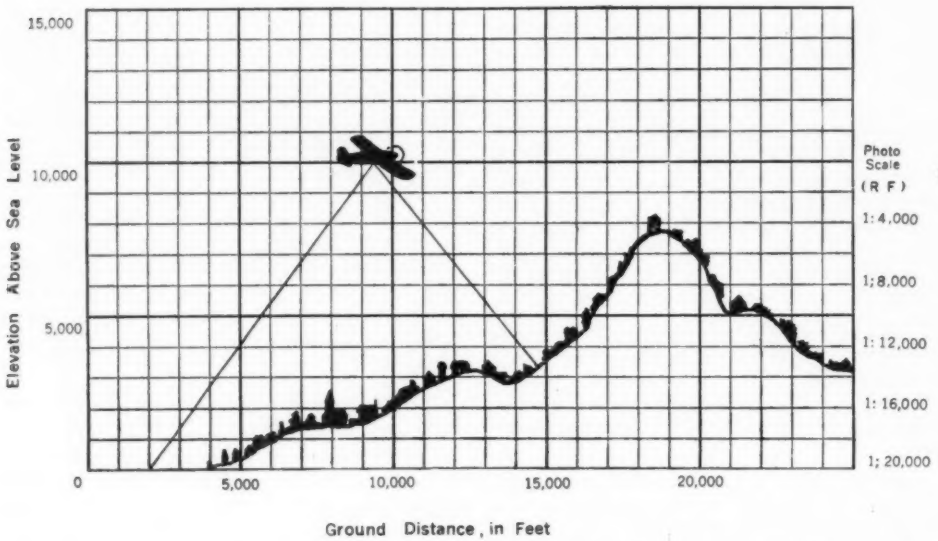
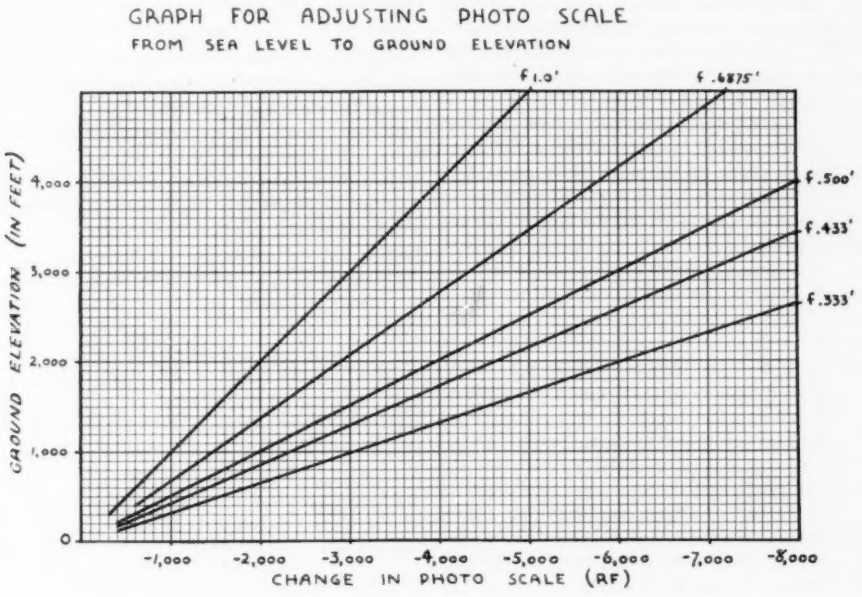


FIG. 1.—The land elevation has an important effect on the scale of aerial photos. The scales in this illustration are based on the use of a camera with a 6-inch focal length.

TABLE 1.—DATA FOR COMPUTING AVERAGE PHOTO SCALE (AT SEA LEVEL) FOR PROJECT 283-A, HERKIMER COUNTY, N. Y.[1]

Observation number	Photo distance (d)	Ground distance (D)	Average elevation (h)	Flying height above sea level (H)	Photo scale at sea level
	Feet	*Feet*	*Feet*	*Feet*	*RF*
1	0.264	4,774	2,016	14,448	1:21,015
2	.325	6,597	1,847	15,802	1:22,985
3	.632	12,413	2,037	15,540	1:22,604
4	.392	7,378	1,785	14,725	1:21,418
5	.464	8,594	1,832	14,566	1:21,186
6	.297	5,729	1,962	15,224	1:22,143
7	.283	5,555	1,953	15,448	1:22,470
8	.342	6,510	1,621	14,708	1:21,393
9	.514	10,069	1,650	15,118	1:21,990
				Average scale	1:22,023

[1]Focal length of camera lens: 0.6875 feet.



Instructions

1. Obtain the average photo scale (*RF*) at sea level and the focal length of the camera lens (*f*).
2. Find the known ground elevation on the left-hand vertical axis and read across to the applicable sloping *f* line.
3. From this intersection read down to the bottom horizontal axis and find the amount of change to make in the *RF*.

Example: With an average photo scale at sea level of 1:21,915 and a focal length of 0.6875 feet, adjust the *RF* for a ground elevation of 1,350 feet.

Reading across from 1,350 to the *f* .6875 line, and then down to the bottom horizontal axis, you find that the change in *RF* for this elevation is —1,950. Therefore, the *RF* for a photo of land at 1,350 feet elevation will be 1:21,915 — 1,950, or 1:19,965.

FIG. 2.—Graph used to adjust photo scale to different elevation.

The last column in Table 2 shows the probable error of scaling ground distances on aerial photographs. For example, project 283-A has an error of 7.5 feet per 1,000. Thus you can expect that any 1,000-foot distance you measure on the photo will be within 7.5 feet of being accurate, two times out of three.

From these and other projects on which this short-cut method of computing average scale was used, it was found that the standard error was about 1 percent when 9 or 10 sample photos were used. Therefore, 9 or 10 samples will usually provide a reliable average scale for any photo project.

How to Compute Scale

Although computing scale is basic in map and aerial photograph reading, we believe it is advisable to include a brief description of the methods of computing scale as applied in this type of work.

Scale is usually expressed as a representative fraction (RF), which is the ratio of a distance on the map or photo to the same distance on the ground. A scale of 1:20,000 means a distance that is 1 inch on the map will be 20,000 inches on the ground.

Formula I

The formula for computing scale is:

$$RF = \frac{f}{H - h}$$

in which f = focal length of camera lens, in feet.

H = flying height of plane above sea level, in feet.

h = elevation of land above sea level, in feet.

The focal length of the camera (f) is obtained from the agency making photographs. The elevation of the land above sea level (h) is obtained from ground control or from U. S. Geological Survey topographic maps.

Formula II

The flying height of the plane above sea level (H) is computed from the following formula:

$$H = \frac{fD}{d} + \frac{{}^{h}G_1 + {}^{h}G_2}{2}$$

in which H = approximate flying height of plane above sea level, in feet.

D = ground distance between points G_1 and G_2, in feet.

d = photo distance between points G_1 and G_2, in feet.

${}^{h}G_1$ = elevation of point G_1 in feet.

${}^{h}G_2$ = elevation of point G_2, in feet.

The flying height (H) obtained is not true flying height, but it is sufficiently close for our purposes. Photo scale for other elevations is computed from Formula I.

Example

Suppose you want the scale for a point whose elevation is 2,200 feet above sea level. The distance between two points on the photo (d) is 0.525 feet and the corresponding ground distance (D) scaled from U. S. G. S. maps is 10,800 feet. The average elevation of the two points (h), from U. S. G. S. maps is 675 feet and the focal length of the camera lens (f) is 0.6875 feet.

$$H = \frac{fD}{d} + \frac{{}^{h}G_1 + {}^{h}G_2}{2}$$

$$H = \frac{(.6875)\,(10{,}800)}{.525} + 675$$

$$H = 14{,}818 \text{ feet}$$

Scale for the point whose elevation is 2,200 feet is computed from Formula I:

$$RF = \frac{f}{H - h}$$

$$RF = \frac{.6875}{14{,}818 - 2{,}200} = \frac{.6875}{12{,}618} = \frac{1}{18{,}353}$$

$$RF = 1{:}18{,}353$$

TABLE 2.—AMOUNT OF ERROR IN SCALING PHOTOS BY SHORT-CUT METHOD, FOR DIFFERENT PROJECTS

Project	Photos scaled	Average scale at sea level	Standard error of average scale	Coefficient of variation	Probable error per 1,000 feet
	Number	*RF*	*Percent*	*Percent*	*Feet*
GSM	8	1:45,500	0.52	1.51	2.7
MB	10	1:24,020	.68	2.1	4.2
CIW-SCS	10	1:34,680	.90	2.8	7.3
M46	40	1:23,500	.49	3.1	9.1
Cooperstown area	6	1:23,100	2.45	5.8	19.6
283-A	9	1:22,023	1.03	3.10	7.5
Franconia	9	1:28,921	1.50	4.60	12.4
CXG	9	1:22,500	1.60	4.45	15.3

Airplane and Helicopter Spraying with DDT for Spruce Budworm Control[1]

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In 1948 tests were conducted with DDT applied by airplane and helicopter for control of the spruce budworm (*Archips fumiferana* Clem.). This work was done near Heppner, Oregon, by the U. S. Bureau of Entomology and Plant Quarantine, in cooperation with the Oregon State Board of Forestry, the U. S. Forest Service, and the Kinzua Pine Mills Company.

Approximately 4,200 acres of infested forest located in the mixed Douglas-fir and grand fir stands of eastern Oregon, on lands of the Umatilla National Forest and the Kinzua Pine Mills Company, were sprayed under contract with a commercial concern between June 22 and July 2. The total area of infestation in the mixed-forest type of eastern Oregon and Washington is estimated at nearly 1½ million acres. In addition, 100,000 acres of high quality Douglas-fir in western Oregon are also infested. The outbreak is by far the most extensive on record for this destructive insect in these two states. The degree of defoliation varies throughout the region and trees are already dying in limited areas. All indications point toward further spread of the infestation, and a heavy loss of timber.

Between 1945 and 1947, the Bureau of Entomology and Plant Quarantine and cooperating agencies conducted experiments in New York and eastern Canada with DDT aerial sprays to control the spruce budworm. Studies of spray formulations, dosages, and equipment during this period have revealed a number of things.

1. Oil solutions appear to be preferable in several respects to either suspensions or emulsions of DDT against the budworm. Emulsions may be most hazardous to fish. Suspensions in the concentrations required for airplane spraying must be mixed just before they are used, and often cause clogging of the distributing apparatus.

2. In oil solutions a dosage of 1 pound of DDT in 1 gallon of fuel oil per acre, when applied from the air with suitable spraying equipment, is sufficient to reduce the budworm population materially.

3. Weather factors greatly influence the distribution of the spray and impose serious limitations on aerial operations. Concurrent studies of budworm development in relation to spray applications have shown that the insect is most vulnerable during the two- to three-week period when the larvae are actively feeding in the elongating shoots. The habits of the insect make timing of spray applications with respect to the development of both larvae and foliage extremely critical. The tiny budworm larvae, upon emergence from hibernation in the spring, enter and mine the needles of the previous year's growth. As soon as the buds swell the larvae leave the needles and enter the expanding buds. While in the unopened buds the larvae are effectively protected from DDT sprays. It is not until the new shoots have expanded at least ½ inch that the larvae move about enough to expose themselves to the spray.

These studies were generally small-scale experiments with light to moderate spruce budworm populations. Proof was needed of the effectiveness of DDT sprays against heavy populations, with practical spraying procedures that could be used on an actual control operation. An excellent opportunity for the additional tests required was afforded by the widespread spruce budworm epidemic in Oregon in 1948.

The Experimental Area

For the 1948 tests an experimental area of 160,000 acres was chosen where spruce budworm populations were generally heavy. The greater part of this area is a timbered plateau, 4,000 to 4,500 feet in elevation, lying north of the breaks of the John Day River and extending from Swale Creek on the east to the Spray-Heppner highway on the west. The forest on this plateau is a two-storied stand of mixed fir-ponderosa pine type. Douglas-fir and grand fir are the species that

[1]The authors acknowledge the assistance of the assistant state forester, John B. Woods, Jr., and his associates of the Oregon State Board of Forestry in handling the administrative phases of this project.

[2]Duke University, School of Forestry, employed by the Bureau during this work.

are susceptible to spruce budworm attack. Together they comprise about 20 percent of the merchantable stand and a considerably higher percent of the understory. In general, the experimental area is typical of much of the forested area in the Blue Mountains of Oregon.

Within the experimental area twelve plots of 350 acres each were selected for spraying, and two additional plots of similar characteristics, but sufficiently removed from the spray plots to avoid contamination due to drifting spray, were reserved as check plots. All the plots were situated within a 5-mile radius of Opal Butte. The spray plots were generally rectangular and were located so as to conform to fir-type areas in which budworm infestation was most severe.

The plot corners were marked with large painted wooden or rock crosses on the ground (where suitable openings occurred), with painted trees, or with white cloth streamers suspended from corner trees. An ingenious method for marking these corner trees, most of which were 100 to 140 feet high, was developed on the project by W. J. Buckhorn. It consisted briefly of shooting a line with a line-throwing shoulder gun over the tree to be marked. The line was then used to haul up a cloth streamer or a paint bomb. The paint bomb, consisting of a quart of aluminum paint in a fiber container in which was inserted a detonator and one quarter of a stick of dynamite, was electrically detonated from the ground. The explosive force effectively scattered the paint through the upper crown so that the tree was visible for some distance from the air, but it did not cause any apparent injury to the tree.

Spray Materials, Equipment, and Procedures

The insecticide was an oil solution of DDT mixed at the rate of 1 pound of technical grade DDT in 1.2 quarts of a hydrocarbon auxiliary solvent diluted to 1 gallon with fuel oil. The spray was mixed in the field with a mobile tank-mixing unit. The dosages tested are listed in Table 2.

Both a biplane (Travelaire 4000) and a helicopter (Bell 47 B-3) were used to apply the spray. The spraying equipment on each aircraft was similar and consisted essentially of a spray tank from which the insecticide was distributed by a pump to a boom fitted with nozzles. On the biplane the spray tank was installed in the front cockpit and the boom was suspended along the full length of the lower wing. On the helicopter the spray tank was divided into two units, each fitted to the sides of the ship behind the pilot's compartment. The spray boom, mounted so as to extend outward from each side of the ship, was 22 feet long. Positive pressure on the spraying system was maintained by a centrifugal pump, wind-driven on the biplane, and motor-driven on the helicopter. Both ships were fitted with commercial spray nozzles producing a hollow cone spray pattern; the nozzles on the biplane had a $\frac{1}{8}$-inch orifice and on the helicopter, a 1/16-inch orifice. When the required number of nozzles was used, the biplane was calibrated to deliver 1 gallon of spray per acre over a 132-foot swath at a normal operating speed of 80 miles per hour. The helicopter was likewise calibrated to deliver 1 gallon per acre over a 70-foot swath at an operating speed of 50 miles per hour.

Because of the elevation at which this operation was carried on, the spray-carrying capacity of the helicopter was limited to about 35 gallons. In contrast, the biplane carried regularly 75 gallons of insecticide. The helicopter was operated from the Kinzua Pine Mills Company's main logging road (elevation 4,350 feet) within the experimental area. A short, straight stretch of this road provided the necessary runway required for successful ascent by the helicopter with a full load. The time saved in operating the helicopter from this roadway, close to the plots, just about compensated for its limited carrying capacity. The airplane was operated from a temporary landing strip (elevation 3,590 feet) in a wheatfield about 9 miles north of the plots.

With but one exception spray flights were restricted to early morning hours, when calm air or low-wind velocities prevailed. Spraying was suspended when the wind velocity reached 6 miles per hour. However, it was found that excessive turbulence rather than high-wind velocity usually limited spraying. One thunderstorm, with light precipitation, occurred during the spraying period, but in all tests the foliage was dry or but slightly damp at the time of treatment.

The direction and alignment of spray runs were governed largely by topography and were for the most part left to the discretion of the pilot. Marking of individual swaths was im-

practical, owing to the dense undergrowth and to the height of the overstory. The procedure used in applying the various treatments was about as follows: Airplane applications of the 1-pound dosage were made in parallel swaths approximately 132 feet apart, and the 2-pound dosages, approximately 66 feet apart. With the helicopter, a ½-pound dosage was applied to one plot in parallel swaths approximately 140 feet wide. Two plots were treated with a 1-pound dosage by applying half the dosage on parallel swaths 140 feet wide in one direction, and the balance on comparable swaths at right angles. The remaining treatment with the helicopter (a 1-pound dosage) was applied in parallel swaths 70 feet wide.

Spray flights were generally made 25 to 50 feet above the overstory trees. Aerial photographs and a type map based on the photographs were used to advantage in laying out the plots and in orienting the air and ground crews. Radio communication between the loading sites and the spraying areas, by means of light-weight radios provided by the Oregon State Board of Forestry, proved of inestimable value in coordinating activities during spraying.

Timing of Spray Application

Since timing of spray applications against the spruce budworm is so critical, the development of larvae and foliage was checked daily before and during spraying to insure that the treatments were applied when the insect was most vulnerable. When spraying was begun, most of the shoots on Douglas-fir were about ½-inch long, while the shoots on grand fir were from 1 to 3 inches long. The status of larval development on each plot at the time of spraying is shown in Table 1. These data also reflect the progressive development of the larvae during the period June 22 to July 2, when spraying operations were underway. Prepupal larvae began to appear on the latter date. It seems evident, therefore, that the insecticide was applied during the period of insect and foliage development when the budworm is most readily controlled by spraying.

Measuring the Effects of the Spray

The effect of the spray was measured by sampling the larval fall from ten sample trees selected along a diagonal line across each plot. These lines ranged from 50 to almost 100 chains in length, and the distance between sample trees ranged from 5 to 10 chains. Douglas-fir and grand fir were sampled in proportion to their occurrence in the stand. Individual trees ranged from about 6 to 14 inches in d.b.h. and from 40 to 75 feet in height. Most of them had long, full crowns, which were supporting a heavy larval population. From one to several days before spraying, a collecting tray made from a cloth strip 3 feet wide, and long enough to spread from one edge of the crown projection to the other, was placed beneath each sample tree. These trays were supported by stakes and weighted along the center to prevent the larvae from wriggling off. The same procedure was followed on the check plots. All trays were cleaned on the day prior to spraying, and no appreciable number of dead larvae were on the trays up to the time of spraying. After treatment the affected larvae were counted daily until most of the larval fall had ceased. This required about a week to ten days, depending somewhat on the effectiveness of the treatment. The trays on the check plots were also examined at regular intervals.

Several hundred larvae from sprayed and check plots were saved for observation. It was soon found that the larvae falling on the trays in the sprayed plots died within a day or two, while those from the check plots survived, except a small number that were parasitized.

Just prior to pupation, when larval drop had reached a minimum, all sample trees were felled on cloth strips. Surviving larval population and residual mortality were estimated from the results obtained by sampling the foliage and counting the larvae caught on the cloth. Total

TABLE 1.—LARVAL DEVELOPMENT OF SPRUCE BUDWORM ON PLOTS AT TIME OF SPRAYING. HEPPNER, OREGON. 1948

Method and date of spraying	Percent of larvae in each instar			
	Third	Fourth	Fifth	Sixth
Helicopter:				
June 22	2	57	41	0
23	2	56	42	0
	0	43	57	0
24, 25	2	43	55	0
25	2	40	57	1
26	1	34	61	4
Airplane:				
June 27, 28	1	25	71	3
28, 29	1	25	71	3
30	0	8	30	62
30, July 1	0	3	29	68
July 1	0	2	19	79
1, 2	0	2	8	90

mortality was computed from the fractional catch of larvae on the sample trays plus the dead counted in the final examination. An index of the total population per sample tree at the time of spraying was derived from the total mortality plus survivors.

Results

The figures for percent control were obtained from the average total population and kill on the sample trees (Table 2).

The three airplane plots sprayed with the 1-pound dosage of DDT showed an average control of 99.6 percent. The tree having the poorest control of any of the 30 sampled on these plots showed a larval kill of 95.2 percent; 22 of the trees had no surviving larvae.

The three airplane plots on which the 2-pound dosage of DDT was applied showed a control of 99.5 percent. Here the lowest degree of control was 93.7 percent on one tree; only 17 of the 30 trees sampled had no survivors.

The five plots sprayed by helicopter with the 1-pound dosage of DDT did not show quite so good control as did those sprayed by plane. One plot, sprayed during the evening, showed a kill of only 91.2 percent of the larvae. Control on the four other plots averaged 98.3 percent. On two of these plots, where double (criss-cross) spray flights were made, control averaged 98.6 percent. On the two other plots control was slightly lower, averaging 97.9 percent. The poorest control on the four plots just referred to was 87.0 percent on 1 tree, and only 4 of the 40 trees sampled had no survivors.

Through an error, one plot sprayed by the helicopter received only ½ pound of DDT in ½ gallon of fuel oil per acre. Control on this plot averaged only 68.3 percent, although control on individual sample trees ranged from 3.8 to 99.7 percent.

All the trees sampled on the two check plots contained heavy larval populations at the end of the experiment, and the natural mortality, insofar as it could be measured, was very low. On these plots, where from 3,000 to 4,000 larvae survived per tree, the larval drop on the trays was only 3.1 to 3.4 percent of the total population.

Discussion

The estimates of the degree of control obtained in these tests are considered to be conservative. For one thing, the larval fall as measured by the tray collections is probably low, since it is known that ants carried off some larvae, and that occasional trays were molested by animals. More important, however, is the fact that, except for one plot, 70 percent of the survivors on the sprayed plots were small, parasi-

TABLE 2.—TESTS WITH SPRAYS APPLIED BY HELICOPTER AND AIRPLANE FOR THE CONTROL OF THE SPRUCE BUDWORM. HEPPNER, OREGON. 1948

Method of spraying and dosage per acre (pounds of DDT or gallons of solution)	Swath width[1] (feet)	Date of spraying	Average number of larvae per tree sampled			Percent control
			Survivors[2]	Killed by spray	Total	
Helicopter:						
½	140	June 26	1,641	3,530	5,171	68.3
1	70	June 22	479	4,937	5,416	91.2
		June 23	107	7,456	7,563	98.6
			208	7,401	7,609	97.3
1	140 (criss-cross)	June 24, 25	224	8,516	8,740	97.4
		June 25	26	12,065	12,091	99.8
Airplane:						
1	132	June 30	5	10,199	10,204	99.9
		30 July 1	12	7,481	7,493	99.8
		July 1	51	4,929	4,980	99.0
2	66	June 27, 28	41	7,743	7,784	99.5
		28, 29	8	13,309	13,317	99.9
		July 1, 2	65	7,013	7,078	99.1
				Larval Drop		Natural Mortality
Check:			4,866	173	5,039	3.4
0			3,179	101	3,280	3.1

[1]Swaths sprayed parallel unless otherwise indicated.

[2]Seventy percent of larvae escaping the spray on treated plots (except the ½-pound dosage) were parasitized, whereas the majority of larvae on the check plots were not parasitized.

tized larvae that escaped the spray, probably through failure to travel and feed. This is somewhat offset by the fact that control percentages in Table 2 have not been adjusted to include the effect of natural control factors. On none of the plots sprayed at the rate of 1 pound in 1 gallon or 2 pounds in 2 gallons per acre, with the possible exception of the plot sprayed in the evening, were there enough surviving larvae to reinfest the sprayed trees to any appreciable extent in 1949.

No spray burning was noted on any coniferous, hardwood, or herbaceous foliage with any of the dosages used on this project.

The contrast between trees on the sprayed and unsprayed areas was striking within three weeks after the spraying was completed. On the treated plots the trees, especially the Douglas-fir, were beginning to green up, with new growth covering the feeding scars and red foliage. The grand fir showed less immediate response. On untreated, infested areas, bare twigs and reddish foliage were increasingly evident, presenting a devastating scene. In many untreated areas the mortality of both Douglas-fir and grand fir is expected to be heavy this year.

It is believed that these experiments demonstrate conclusively that heavy spruce budworm infestations in Douglas-fir and grand fir can be controlled in the mixed fir-pine forests of eastern Oregon, if spray—at the rate of 1 pound of technical grade DDT in 1 gallon of fuel oil per acre—is applied during the quiet morning hours at a time when the spruce budworms are in the late larval stages. Furthermore the spray can be applied by airplane or helicopter, the plane being cheaper. The helicopter has the advantage, within its operational ceiling, of being usable on areas where a lack of adequate airfield facilities is the limiting factor.

Summary

In 1948 tests were conducted on airplane and helicopter spraying with DDT to control the spruce budworm (*Archips fumiferana* Clem.).

Approximately 4,200 acres of infested forest in twelve 350-acre plots located in the mixed Douglas-fir and grand fir stands of eastern Oregon on lands of the Umatilla National Forest and the Kinzua Pine Mills Company were sprayed.

Excellent control was obtained with both 1 pound of technical grade DDT in 1 gallon of fuel oil per acre, and 2 pounds of technical grade DDT in 2 gallons of fuel oil per acre; however, the former dosage produced results nearly as good as the latter. A dosage of ½ pound of technical grade DDT in ½ gallon of fuel oil per acre gave unsatisfactory control.

The spray was applied during the short period in budworm development when the larvae are most vulnerable to insecticidal attack, i. e., when they are actively feeding on the expanding foliage.

The ability of the helicopter to operate from an improvised landing area close to the plots compensated for its limited carrying capacity in comparison with the airplane.

The aircraft spraying equipment used in this study, the method of timing the spraying, and the system used in checking the effects of the treatments on budworm larvae are described.

Predicting the Volume and Normality of Reproduction Stands of Douglas-Fir

With the increased emphasis placed upon the acquisition and protection of land bearing only trees of reproduction size in the Douglas-fir region has come the necessity of appraising such land and preparing management plans for it. This forest land is usually classified by the stocked-quadrat method but for management purposes it is necessary to know what yields may be expected during and at the end of the rotation. The data presented here are the first attempt to bridge the gap from quadrat stocking to cubic-foot volumes at an age where yield tables may be used.

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WHAT will be the wood volume in Douglas-fir stands now less than 15 years old when they reach 20 to 30 years of age? What does 40-, or 50-, or 75-percent stocking, measured by the stocked-quadrat method (*3, 4, 5, 8*), mean in terms of timber volume when the stands become old enough to compare with those represented in normal yield tables? What stocking during the reproduction period will develop a reasonably full stand at age 20 to 30 years and permit early intermediate cuttings?

Foresters managing reproduction stands of Douglas-fir need answers. Stocking of such regenerating areas is usually measured by the percent of standard quadrats having at least one well-established tree. The size of the quadrat is usually so chosen that 100-percent quadrat stocking provides for a full stand at maturity, but not necessarily at earlier ages. In the Douglas-fir region the quadrat most commonly used is 1/250-acre. What stocking so determined will mean in terms of normality when the stands are old enough to be compared with yield table standards has not been known. Such information is needed at early ages to predict the quality and value of future stands and the values that might be realized in thinnings.

Field work on such a study was carried out in central western Washington, including Thurston, southern Mason, eastern Grays Harbor, western Lewis, and southwestern Pierce Counties in 1946-47.

Basic Data

Stands of Douglas-fir ranging from 15 to 35 years old and from very poorly stocked to well stocked were sampled along transect lines. At 5-chain intervals four 1/250-acre quadrats were laid out (a circle 14.9 feet in radius divided into four sectors) and the number of quadrats,[1] judged from stem analyses to have been stocked 15 years ago, was tallied. In so doing no attempt was made to evaluate effect of mortality on the number of quadrats stocked. It seems probable that such loss would have had little effect on the estimate of past stocking since in young stands there likely would be little or no death from competition if there were only one tree on each quadrat. If there were more than one, the quadrat likely would remain stocked even after one or several trees had died. At the same points where quadrat counts were made one-twentieth-acre plots were established and the trees tallied by species and d.b.h. It is the volume on this one-twentieth-acre plot, as determined from the tally, that was correlated with the number of quadrats stocked 15 years ago. Site and stand age were estimated from borings made on dominant or codominant trees on each plot.

Methods and Results of Analysis

The objective in the analysis is to determine for each site class and age class the expected normality 15 years hence for stands varying from zero to 100 percent stocked now, where stocking is measured by the quadrat method.

The data were first analyzed by multiple linear correlation. The correlation coefficient between volume at the time of examination and site, age, and number of quadrats stocked 15 years earlier is 0.77, indicating a strong relation between volume and the independent variables. Preliminary graphic analysis, however, indicated that the series of evenly spaced straight lines defined by the equation was not a satisfactory fit for the data. Curvilinearity was indi-

[1] Actually stocking was based on inspection of "quadrants," the one-fourth part of a circle. To avoid confusion, however, they will be referred to as quadrats throughout this report.

cated. Consequently, a combination of least squares and graphic methods was used.

First the data were separated into groups according to site class and number of quadrats stocked 15 years prior to the time of examination. For each group a linear regression of volume over age was fitted by the method of least squares. The straight lines thus determined were erratic both as to slope and elevation. They were harmonized in two steps. First, the growth per acre per year computed from the regression lines was curved over the percent of stocking with the result shown in Figure 1. Second, the volume per acre at 20 years of age was determined from the regressions after adjustment for the growth rates read from the curves. These 20-year volumes were then curved as in Figure 2. Thus, by reading the volume at age 20 years for any degree of stocking at age 5 years from Figure 2 and the corresponding growth per acre per year from Figure 1 a volume-over-age curve may be drawn for any quadrat stocking percent for any site class.

Volumes read from such curves were next converted to percent of the normal volume shown in the Douglas-fir yield table[2] (*6*). These values were plotted over percent of quadrats stocked and curved. The resulting predicted normality corresponding to various combinations of present stocking, site class, and age of stand are given in Figure 3 and Table 1. Table 2 shows the corresponding cubic-foot volumes.

[2]Total stand used, i.e., trees 1.5 inches d.b.h. and over.

Discussion

Figure 3 shows that for any present percent of quadrat stocking, higher cubic-foot volume normality can be expected on the better sites for the older stands. Compare, for example, two stands, one 5 years old on site V land, the other 15 years old on site II. If both have 100 percent quadrat stocking now the prediction is that the 5-year-old site V stand will have only 35 percent of normal cubic-foot volume 15 years hence, while the 15-year-old site II stand will support 94 percent of the normal volume 15 years hence.

This apparent anomaly results from the fact that 100 percent quadrat stocking means approximately the same number of trees per acre regardless of site or age (within the range of these data), but many more 20-year-old trees are required to utilize fully site V lands, for example, than are 20- or 30-year-old trees which average larger on site II lands. Although volume does not vary in direct proportion to number of trees, the differences in expected volume normality for a range of sites and ages are still great for a given present quadrat stocking. This inability of the 1/250-acre quadrat to sample adequately for growth prediction all sites and ages also accounts for the wider departure from the normal of growth and volume trends found on site V than on the better sites. Similar reasoning may explain why a given quadrat stocking in 5-year-old stands was found to result in

TABLE 1.—PREDICTED CUBIC-FOOT VOLUME NORMALITY AFTER 15 YEARS FOR REPRODUCTION STANDS OF DOUGLAS-FIR IN CENTRAL WESTERN WASHINGTON CLASSIFIED BY AGE, SITE CLASS, AND PRESENT STOCKING

Present stocking (percent of 1/250-acre quadrats stocked)	Present age 5 years				Present age 10 years		Present age 15 years	
	Site class II	Site class III	Site class IV	Site class V	Site class II, III, IV	Site class V	Site class II, III, IV	Site class V
	Percent normal 15 years hence							
5	11	10	7	1	11	3	12	4
10	20	16	11	1	20	6	22	8
20	33	26	18	3	35	11	39	15
25	38	29	21	4	41	14	46	18
30	42	32	23	5	47	16	52	21
40	50	37	27	9	56	22	64	28
50	56	41	30	12	63	27	72	33
60	62	45	34	17	70	31	79	37
70	68	49	37	21	75	35	85	40
75	71	51	39	23	78	37	87	41
80	74	53	40	26	80	38	89	43
90	80	57	43	30	83	41	92	46
100	86	60	46	35	86	43	94	48

cubic-volume normalities 15 years later which were higher, the better the site, although on sites II, III, and IV supporting 10- and 15-year-old stands, a given quadrat stocking was found to result in volume normalities 15 years later that did not differ significantly by site.

It will be noted that some of the growth rates read from Figure 1 are greater than those given by the yield table for fully stocked stands, even though at 20 years the stands studied were below normal in cubic volume. This discrepancy apparently results from the way understocked stands develop—a process as yet imperfectly understood. Regeneration on broad cutovers may take place over many years with the stands gradually filling in (*5*). Such stands obviously are not even-aged to the year and the greater-than-normal growth rate may be explained by the continued recruitment of stems into the 2-inch class even after the main stand is 20 years old. In stands which have the normal number of trees from the start this recruitment is completed at an earlier age.

Within the variety of stand conditions sampled there was considerable range in volume on plots having the same quadrat stocking class, the same site class, and trees of the same age class. Part of this variation is due to the sampling errors involved in determining age, site, and stocking; the remaining variation is not explained by any of the factors tested.

To give some idea of the accuracy with which predictions might be made, deviations from regression were computed for the plots used in this analysis. This measure includes error from both the sources referred to above. It was found that if 100 groups of four quadrats (the recommended number) had been taken in each site class the errors of predicted volumes would have been within 15 percent of measured volume 19 times out of 20.

Before explaining the application of the

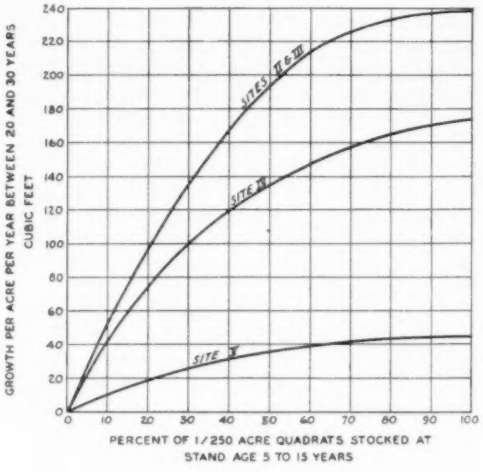

FIG. 1.—Predicted growth per acre per year in Douglas-fir stands from age 20 to 30 years by site class and percent stocking at stand age 5 to 15 years.

TABLE 2.—PREDICTED CUBIC-FOOT VOLUME[1] AFTER 15 YEARS FOR REPRODUCTION STANDS OF DOUGLAS FIR IN CENTRAL WESTERN WASHINGTON, BY AGE, SITE CLASS, AND PRESENT STOCKING

Present stocking (percent of 1/250-acre quadrats stocked)	Present age 5 years				Present age 10 years				Present age 15 years			
	Site class II	Site class III	Site class IV	Site class V	Site class II	Site class III	Site class IV	Site class V	Site class II	Site class III	Site class IV	Site class V
	Cubic feet per acre 15 years hence											
5	170	120	60	10	310	250	170	30	490	400	270	50
10	310	200	100	10	570	460	310	60	900	730	500	110
20	510	320	160	20	990	800	550	100	1,600	1,290	890	200
25	590	360	180	20	1,160	930	640	130	1,890	1,520	1,040	240
30	650	400	200	30	1,330	1,070	740	150	2,140	1,720	1,180	280
40	780	460	230	50	1,580	1,270	880	200	2,630	2,110	1,450	370
50	870	510	260	60	1,780	1,430	990	250	2,960	2,380	1,630	440
60	960	560	300	90	1,980	1,590	1,100	290	3,250	2,610	1,790	490
70	1,050	610	320	110	2,120	1,710	1,180	320	3,490	2,800	1,930	530
75	1,100	640	340	120	2,210	1,770	1,220	340	3,580	2,870	1,970	550
80	1,150	660	350	140	2,260	1,820	1,260	350	3,660	2,940	2,020	570
90	1,240	710	370	160	2,350	1,890	1,300	380	3,780	3,040	2,090	610
100	1,330	750	400	180	2,430	1,960	1,350	400	3,860	3,160	2,130	640

[1]Volume of entire stem, including stump and top, for all trees 1.5 inches d.b.h. and over.

curves and tables it should be pointed out that the curves of normality and volume are not reliable for the very poor stocking classes. Hence, they should not be applied to lands where the present stocking is less than 10 or 15 percent. Under good management, stocking of such areas should be improved by interplanting anyhow. Also, because the 1/250-acre quadrat is not sensitive to changes in stocking of stands having more than about 1,500 trees per acre, these data must be applied with caution to high-density stands. Normality percents read from the curves represent averages for the stands studied, and a particular stand now fully stocked by number of quadrats may actually have many more trees per acre than the average, and hence an expected normality higher than the curves predict. Analysis indicates that if more than 700 trees per acre are likely to be present on the area 15 years hence the predicted volumes should be increased about 10 percent.

Application

To apply the method one needs to know the present age of the stand, the site class, and the present stocking. Age should be the average age of the trees expected to become the dominant-codominant stand, excluding scattered older trees on the area. For most accurate results, age of these trees should be known to the nearest year. Site class of the area must be determined since predicted volumes vary so greatly with site.

Present stocking is determined by the stocked-

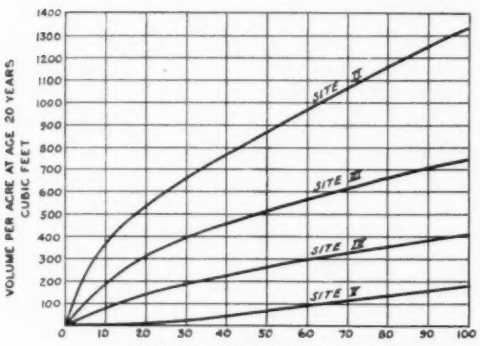

FIG. 2.—Volume per acre in Douglas-fir stands at age 20 years by site class and percent stocking at age 5 years.

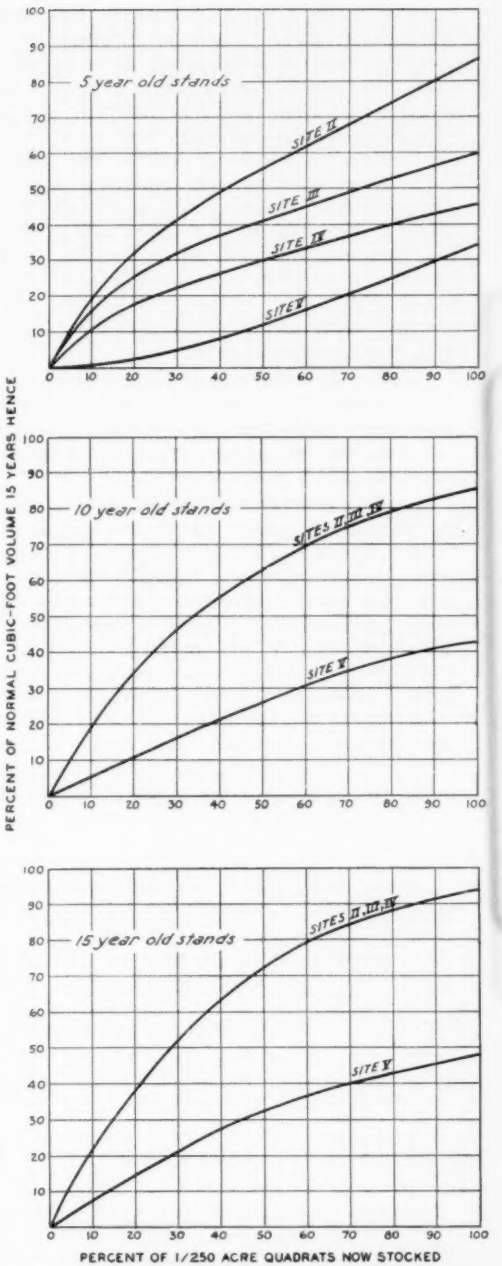
PERCENT OF NORMAL CUBIC-FOOT VOLUME 15 YEARS HENCE
5 year old stands
SITE II
SITE III
SITE IV
SITE V
10 year old stands
SITES II III IV
SITE V
15 year old stands
SITES II III IV
SITE V
0 10 20 30 40 50 60 70 80 90 100
PERCENT OF 1/250 ACRE QUADRATS NOW STOCKED

FIG. 3.—Predicted normality 15 years hence by present stocking, age, and site class for reproduction stands of Douglas-fir.

quadrat method using 1/250-acre quadrats. Quadrats should be taken at intervals of 5 chains, or less on small areas, along transect lines that cross the major drainage pattern of the area. Quadrats should be tallied in groups of four because the basic data were so collected. Where square quadrats are used the four should have a common corner, each quadrat being 13.2 feet on a side. The same results may be obtained using a circle 14.9 feet in radius and divided into four sectors, each sector serving as a quadrat. A quadrat is considered stocked if it has on it at least one established seedling. The quadrat groups should be tallied as having 0, 1, 2, 3, or 4 quadrats stocked.

Four hundred quadrats or 100 groups of four should normally be taken to sample an area where the reproduction is all of about the same age class, the same general stocking class, and where the site is fairly uniform.

Sampling results should be summarized into the percent of groups having zero quadrats stocked, 1 stocked, 2 stocked, 3 stocked, and 4 stocked. The volume or normality percent is then determined from the curves or tables for each classification. 1 quadrat representing 25 percent stocking; 2, 50 percent; 3, 75 percent; and 4, 100 percent. The results are then weighted by the number of groups of quadrats in each class and the average volume per acre or normality percent computed.

For example, suppose a site III area supports a 10-year-old stand. One hundred groups of four quadrats taken along transect lines were tallied as follows: Zero stocked, 10; 1 stocked, 25; 2 stocked, 37; 3 stocked, 17; 4 stocked, 11. Average normality percent would be computed as follows, with information from Table 1:

0 quadrats	.10 x	0	= 0.0
1 "	.25 x	41	= 10.2
2 "	.37 x	63	= 23.3
3 "	.17 x	78	= 13.3
4 "	.11 x	86	= 9.5
			56.3, estimated percent normal 15 years hence

For average volume determination the same computations would be carried out using table 2:

0 quadrats	.10 x	0	= 0
1 "	.25 x	930	= 230
2 "	.37 x	1,430	= 530
3 "	.17 x	1,770	= 300
4 "	.11 x	1,960	= 220
			1,280 cu. ft., estimated volume per acre 15 years hence

The volumes and normality percents thus determined are the predicted values for the stand when it reaches 25 years of age. Standard yield table techniques may then be applied to predict growth and volumes farther into the future (*1, 2, 6, 7*).

For very young stands in process of establishment it may be desirable to predict volumes for more than 15 years ahead. To do this, we must estimate what the quadrat stocking will be when the stand is 15 years old and then using tables 1 and 2 predict volume and normality from that

TABLE 3.—PREDICTED STOCKING AFTER 15 YEARS IN UNDERSTOCKED REPRODUCTION STANDS OF DOUGLAS-FIR, CLASSIFIED BY CERTAIN SITE FACTORS FOR AREAS HAVING GOOD SEED SOURCE[1] IN CENTRAL WESTERN WASHINGTON

Present stocking (percent of 1/250-acre quadrats stocked)	Favorable exposures[2] All slopes		Unfavorable exposures[3] Slope 15-40 percent		Slope 41%+
	Brush cover light to medium[4]	Brush cover heavy[5]	Brush cover light to medium[4]	Brush cover heavy[5]	Any brush cover
	Stocking percent after 15 years				
5	57	37	41	34	30
10	60	41	44	38	33
20	64	47	50	45	41
30	68	54	57	52	48
40	73	60	63	59	
50	78	67	69		
60	82	74	75		
70	86	80			

[1]Area generally within twice the height of trees of seed-bearing age.
[2]Includes NW, N, NE, E, and SE exposures on slopes 15 percent and over and all exposures on slopes less than 15 percent.
[3]Includes S, SW, and W exposures.
[4]Low brush covering up to 75 percent of the ground or high brush up to 50 percent crown cover.
[5]Low brush covering over 75 percent of the ground or high brush over 50 percent crown cover.

age forward. If conditions are favorable for regeneration, quadrat stocking will normally increase while the stand is growing to age 15 years. Table 3 shows how stocking was found to improve, on the average, when a good seed source is available under various exposures, slopes, and brush covers in central western Washington (*9*).

An example will best explain the method. Suppose we wish to predict what the volume of a stand now 3 years old will be when it reaches 30 years. It is on site III land, has a good seed source, i.e., unstocked quadrats are generally within a distance of twice the height of seed-bearing trees, the brush cover is light, the slope is 20 percent on a west (unfavorable) exposure, and at present 40 percent of the quadrats are stocked. Table 3 shows that such a stand will likely have 63 percent of its quadrats stocked 15 years hence—an increase of 23 percentage points. Since, when the stand is 15 years old, 12 years of this period will have elapsed we may assume that 12/15 of the 23-point increase will have taken place or 18 percentage points. Thus, since the trees in the present stand will likely become the dominants and codominants, our best estimate is that at age 15 the stand will have 58 percent of its quadrats stocked. Table 2 shows that it should support about 2,560 cubic feet per acre at 30 years of age, which is 78 percent of normal volume.

Summary

The objective of this study is to devise a method for predicting the normality and volume of reproduction stands of Douglas-fir. Such young stands are measured by the stocked-quadrat method and this expression of stocking is related to the normality by cubic-foot volume after the stands are old enough to be compared to normal yield table values, in this study 20 to 30 years of age.

Field work consisted of measuring over 700 temporary 1/20-acre sample plots, 285 of which were finally used in the analysis. In analyzing the data a combination of least squares and graphic methods was used.

The results of the study are shown in curves and tables giving predicted normality percent and volume after 15 years for stands of a given present stocking, age, and site.

Application of the results to stands in central western Washington is discussed, illustrating the use of the various tables and curves.

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Notes

Carlos Glazier Bates

Carlos G. Bates died July 22, 1949 at his home, 1759 Lindy Street, St. Paul, of a heart attack.

He was born in Topeka, Kansas, October 14, 1885, and was graduated from the University of Nebraska in 1907.

Entering the U. S. Forest Service, in Colorado, in 1907, he spent the remaining 42 years of his life in that service. Since 1928 he had been attached to the Lake States Forest Experiment Station, University Farm, St. Paul.

Among the important forestry projects on which Mr. Bates took part were reforestation of the Nebraska sandhills; forest influence studies at Wagon Wheel Gap, Colorado, and LaCrosse, Wisconsin; reforestation studies in the Lake States; and shelterbelt work in the Great Plains.

One of the early pioneers in scientific forestry, he started his career as a forester during the presidency of Theodore Roosevelt and when Gifford Pinchot was the chief forester, at a time when the American people were just awakening to the need of doing something for the protection of their forest wealth. Forestry as a science did not yet exist.

Coming from the wide spaces of Kansas and Nebraska, he was always partial to the prairie region. One of his first projects was to start planting trees in the prairies around homesteads and around cultivated fields to protect them from the hot, drying winds. At first people thought it was all foolishness, but now shelterbelt planting has become an established part of agriculture in the Great Plains region.

He was particularly interested in the relationship between the forests, the climate, the runoff, erosion, and all such things. He was one of the few young men who suggested to Gifford Pinchot the needs for establishing forestry experiment stations, and he was one of the first directors of a forestry station at Halfway on Pikes Peak in Colorado.

Besides being a good forester, he was an excellent engineer. If he had applied himself to the engineering profession, he probably would have become one of the outstanding engineers of the country. His capacity for work was simply enormous, and he never spared himself. He published many bulletins, articles, and enjoyed the prestige and reputation for his knowledge, willingness to help his coworkers; and although somewhat stern in appearance, he really had a golden heart. He was a Fellow of the Society of American Foresters, and in 1930 was chairman of the Minnesota Section.

Custody Provided for Documentary and Historic Motion Pictures on Forestry

During the early years of the present century, numerous lumber companies and trade associations, as well as public agencies, produced motion pictures on forest utilization, fire control, and other aspects of conservation. Some of these motion pictures are documentary in nature and have considerable historical value. For example, a motion picture produced by the Southern Cypress Manufacturers Association includes a scene that cannot now be duplicated—pull-boat logging.

In order that such motion pictures, whether negatives or prints, may be saved for posterity, the New York State College of Forestry, at the suggestion of the Society of American Foresters, has agreed to provide storage space and serve as custodian of any films of this nature.

Any forestry or forest products organizations, including manufacturers and trade associations, that have such films and desire to have them preserved for posterity, are invited to get in touch with the New York State College of Forestry at Syracuse 10, New York.

The college will catalogue the films and provide storage space for them as a public service to the forestry profession and the forest products industries. The college is not in a position to purchase films and should not be offered films for sale.

We Present

H. A. Smith
Southern Forester From the North

ON a drowsy summer day about twenty-five years ago, a trial was proceeding on its monotonous plodding way in the old court house at Mauch Chunk, Pennsylvania. The judge, the witnesses, the spectators, the defendant, and even the prosecuting attorney seemed to be in that somnolent state so typical of the atmosphere of courts, funeral parlors, and similar places of gravity and gloom. The commonwealth, represented by a young forester, was prosecuting a forest fire case, but it was going badly because the county attorney's heart was not in his work, and the defendant, simply by keeping his mouth shut, was clearly due for acquittal. Suddenly, with the air of a man whose patience is at an end, the forester rose from his seat, interrupted the prosecutor's forensic gobbledegook, and with great force and fluency offered a dozen fast reasons why the defendant should be fined or imprisoned, or both.

In a moment the learned judge was wide awake, trying to follow the arguments shot at him by the forester. When the flurry of sound finally ceased, his honor riffled through the pages of a legal tome, then, clearly perplexed, said, "Young man, I can't seem to find the statute you have cited in this case. What law are you quoting?"

Half sheepishly, half cockily, the forester replied, "Smith law."

The forester was H. A. Smith. Realizing that the case was practically lost because of legal loopholes, he made a last-ditch attempt to salvage the situation with an appeal to the judge to consider the evidence not alone on what the law said, but on what, in his opinion, it should say. Strangely enough, though the case was not won, neither was it wholly lost; the defendant was acquitted but required to pay the costs of the suit.

As much as anything can, this incident typifies the realistic attitude which has characterized Smith's approach to the dilemmas of life and of forestry. Because of this attitude, plus an engaging sense of humor, his career has not lacked color and action.

Homer Arthur Smith was born in Waynesburg, Greene County, Pa., December 19, 1894. After graduating in 1916 from the State Forest Academy at Mont Alto, where he was known as Big Smith to distinguish him from another student called Little Smith, he was appointed to a field position in the Pennsylvania Department of Forestry, but left the following year to serve with the 20th Engineers, A.E.F.

Returning to the State Forest Service in 1919, he became three years later district forester of the Weiser Forest District, then one of the toughest forest fire areas in the country, a district of one million acres of great inflamability and unusual fire risk in the heart of the highly industrialized anthracite region. Here his native organizing and administrative ability grew to fruition despite the recurring frustrations of an almost insoluble protection problem.

On a vacation trip through the South during the 1920's he had been impressed with the tremendous forestry opportunities possible through better protection and more efficient state admin-

HOMER ARTHUR SMITH

istration. From Florida, which had established a state board of forestry in 1927, he was offered appointment as assistant state forester, accepted with enthusiasm, and went to work with characteristic energy.

South Carolina also had started a forestry program in 1927. When in 1931 the Commission of Forestry appointed him state forester, he helped start a decade of notable progress, not alone for South Carolina but for the other southern states as well. The 1930's were the nascency of southern forestry. Under H. A.'s stimulus, as state forester and secretary to the South Carolina Commission of Forestry and Parks, the nature and scope of public forestry and land use swiftly changed from small-scale efforts on a limited front to intensive effort on a broad front. In eight years appropriations increased tenfold. Nursery production rose from less than a half-million to more than 25 million trees. Technical and field staff were recruited in numbers that could effectively deal with the spreading fire control organization and the increment of substantial state forest and park holdings. Sensing fully the inherent multiple-use potential of forest lands, especially for recreational purpose, he persuaded the commission to undertake the establishment and operation of a dozen or more state parks. Where the opportunity was right arrangements were made for cooperation with federal wildlife interests in the establishment of refuge areas upon state lands. Effective cooperative arrangements also were built up with Clemson College's Extension Service so as to embrace the hitherto neglected field of farm forestry.

The South Carolina era brought to Smith such responsibilities as that of serving as president of the Association of State Foresters in 1937.

Biologically, it is well known that the man or beast most able to adapt itself to its environment has the best chance for survival and success in the competition for existence. Smith, adaptable both by nature and training, had quickly become professionally and personally identified with the South. His enthusiasm for southern opportunities were no less ardent than sincere. Believing that good land management as a way of American life is moral—and exploitation, immoral—he was well qualified by experience and conviction to meet the next responsibility offered him in 1941, a position in the Division of Reservoir Management of the Tennessee Valley Authority, at Guntersville, Ala.

The transition from state forester to manager of properties with a regional resource development agency was, for H. A., as natural as it was logical. The scale was different, the relationships altered somewhat, but the concept and the problems were the same. Guntersville became the hub of activity from which 23,000 acres of farm and 63,000 acres of forest land were put to work. There were river terminals to operate, agencies to be interested in creating public parks, cabin sites to be developed, malarial mosquitoes to be combatted, dams and powerhouses to be protected through the war years, timber to be harvested, fields to be fertilized, large areas to be set aside under cooperative arrangements for the development of migratory waterfowl refuges, public shooting areas, and supplemental feeding grounds; and provision had to be made for the expanding commercial fisheries, the musseling industry, the needs of thousands of sport fishermen, and other activities of a multiple land and water use regional project.

The impoundment of Wheeler and Guntersville reservoirs, some 130 miles long in their sweep across north Alabama, created a vast, and different resource. Competing and often conflicting demands arose for utilization of the lands along their margins. Planning commissions, chambers of commerce, and farmers' land use associations were tapped as local advisors in an effort to democratize the process of achieving balanced adjustments of the new and versatile resource base.

Out of this situation, which easily could have produced chaos and an embittered citizenry, H. A. with his integrative ability brought harmony of use and widespread public understanding and support.

The requirements of this new and demanding job did not stand in the way of Smith's continued service to the profession of forestry for during 1942 and 1943 he devoted considerable time to the affairs of the Society of American Foresters as a member of the Council.

Men who have worked with H. A. see in him the prototype of the forester of tomorrow—the forester with perspective, who looks upon the forest as something more than just a collection of trees, the forester to whom no resource or no man is a stranger. Tomorrow's forester will have to step lively to match his record.

HOWARD E. BALL
HENRY CLEPPER

Reviews

Trees: the Yearbook of Agriculture. Compiled in the U. S. Department of Agriculture. 944 pp. Illus. For sale by Supt. of Documents, Washington 25, D. C. 1949. $2.

The heftiest tome on forests and forestry since the Copeland report, this volume is the work of 175 writers and artists, and by rough estimate contains in its some 900 pages, exclusive of the index, more than one-half million words in 140 chapters. In addition to numerous line drawings, some of which are beautifully executed, there are 16 pages of colored photographs of distinction. Moreover, the typography is of an attractiveness not often associated with government publications, and the cover is truly handsome. In truth, the book's physical features make it a most desirable two-dollar value in this year's crop of forestry literature.

According to the editor—Alfred Stefferud of Agriculture's Office of Information—the purpose of the book is "to put into clearer perspective some items of history, importance, administration, and outlook that have so far been in scattered form." Primarily, it attempts — and unfortunately succeeds somewhat at the expense of a more rounded treatment—to explain forestry in terms of the work of the Department of Agriculture and largely from the viewpoint of the Department's employees and policies.

Compiled under the direction of a departmental committee of which Dana Parkinson of the Forest Service was chairman, the yearbook is so organized as to show first the esthetic values of trees and forests, then the economic, social, silvicultural, and other values. In short, the book is a rather successful synthesis of numerous separate, though not unrelated, aspects of forestry; and the combination of its many parts is in general both logical and orderly.

By and large, the authors selected to write on specific subjects have been splendid choices. For example, who is better qualified to write on forest types of the United States than William A. Dayton? Who better qualified to treat the subject of windbreaks and shelterbelts than Joseph H. Stoeckeler and Ross A. Williams? Or Arthur Koehler on growing better timber? Or Frank Heintzleman on the forests of Alaska? Or Paul Keen on pine bark beetles? Or A. A. Brown on forest fire? Or Edward H. Graham and Lloyd Swift on forest wildlife? Or Carl Hartley on wood fungi? Or Samuel T. Dana on forestry education? Or A. C. Cline on future requirements for timber?

In the case of several topics, authors wholly outside the Department of Agriculture were asked to contribute chapters. The results of this collaboration are splendid. But one wonders why it was not followed to its logical conclusion; as for example, why was not at least one industrial forester asked to contribute to the five chapters concerned with private management?

In his longish chapter "Large Private Holdings in the North" Hardy Shirley singles out certain industrial organizations by name for their forestry work and offers special commendation for those whose programs he finds progressive. Likewise, the chapter on private forestry in the South names certain companies for their sustained-yield policies. But the chapter "Private Forestry in the West," a region where at least one or two companies, or one or two tree farms, could have been mentioned as outstanding examples of enlightened forest management, fails to mention a single firm or association by name. Whatever the reason for avoiding such mention, the result is a palpable inconsistency in the treatment of this significant topic.

In truth, despite the plethora of material here assembled, the book has certain notable shortcomings. Were the scope of subjects limited and the length circumscribed, it would be carping to criticize the volume for what it is not. But when a work runs to more than 900 two-column pages and in excess of a half-million words, then any apparent omissions become noticeable because lack of space cannot be the reason.

Consider this: There are chapters on national forestry, community forestry, state forestry, private forestry, recreational forestry, and most other kinds of individual forestry effort. But there is no single chapter dealing with the important subject of forestry in relation to soil conservation, particularly with respect to the organization of soil conservation districts.

In the chapter "Railroads and Foresters" 90 lines are devoted to the Seaboard Air Line Railroad which initiated a forestry program in 1937. But the only reference to the Charles Lathrop Pack Forestry Foundation, America's only privately endowed forestry foundation which has

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been a notable influence on the progress of forestry during the past two decades, is a one-line comment.

In the chapter "Industrial Forestry Associations" 140 lines are devoted to the American Forest Products Industries, Inc., started in 1941. But the Society of American Foresters, organized in 1900, the only national professional forestry society in America, is accorded a half-dozen casual references in connection with other matters. And the JOURNAL OF FORESTRY, which has been to the development of technique what the Society has been to the advancement of the profession, is not mentioned at all. In fact, the comprehensive index lists neither the JOURNAL nor *American Forests* magazine, two of the oldest and most influential forestry periodicals in the world.

A chapter is devoted to "Trail Riding in the Wilderness," sponsored by the American Forestry Association. But the association itself, which was organized in 1875 and which unquestionably has been the most potent nongovernmental influence in forest conservation, is accorded only a few lines in the chapter on "The History of Forestry in America."

Perhaps the most serious omission in this otherwise comprehensive work is the absence of a chapter devoted to the important subject of research. To be sure, the chief of the Forest Service mentions research briefly in the concluding chapter, "A National Program for Forestry," but the curious reader will seek in vain for a definitive and detailed explanation of the principal problems requiring further investigation. Several chapters on the work of the Forest Products Laboratory are provided the reader interested in wood, but the nine forest experiment stations are not catalogued. A listing of the experiment stations and their addresses would have been quite as useful as the lists of vacation areas in the national forests, wilderness areas, natural areas, nurseries, and the numerous other lists and reference material provided in abundance.

Not to put too fine a point on it, this yearbook for all its bulk lacks a certain balance in emphasis which may be imperceptible to the casual reader, but which a conscientious reviewer cannot fail to note. A defect, perhaps not serious but nevertheless typical, is the apparent desire of the editor to try to make the book suit all tastes. For example, a brief glossary of terms is included. But instead of being called a glos-

sary, it has been given the title "Some Words Woodsmen Use." Included among these words are such terms as *abscission, endemic, enzyme, monoecious, mutation, photosynthesis, saprophyte,* and similar examples of scientific nomenclature. It is absurd to suggest that woodsmen use these words; they never even heard of them.

To sum up, *Trees* is a fascinating, readable, attractive, well edited monumental volume. Its reasonable cost makes it a splendid bargain, and an owner may gain numerous hours of instruction and enjoyment from it.

In his capacity as a book reviewer the present writer has an obligation to be objectively critical. But as a forester with an intense respect for the literature of forestry, he has an equally insistent urge to applaud those works which add lustre to his profession.

Salute to *Trees!*

HENRY CLEPPER.

A Study of the Ecology and Economic Value of Crop Field Borders. By Charles Arthur Dambach. 205 pp. Illus. Ohio State University Press, Columbus, Ohio. 1948. $3.50.

In partial fulfillment of the requirements for his degrees, Dr. Dambach has evaluated broadly the cropland field border problem in a limited area. At the beginning of these studies, his interest was in the relation between the border and birds and mammals. He quickly recognized the impossibility of a fair appraisal, if he confined himself to this phase. His examination of the literature on the subject revealed the weak position of earlier workers, who viewed only one part of the problem. In this thesis, a broad ecological and economic attitude is expressed.

The limited area (Perry and part of Madison Townships of Montgomery County, Ohio) under observation is recognized and even though the studies extended over more than five years, the need for more time to cover longer samples is pointed out. No categorical conclusions were drawn. The facts revealed are itemized. The author points out that they may have wider application. Practicing technicians may be able to interpret them in terms of a particular problem.

The term field border as used in the title means several things, which must be understood to interpret the conclusions reached. Some points might have been clearer if the conclusions separated field borders by heights. It can be inferred that on field edges, crop reduction resulting from competition between crops and border plants is directly proportional to the height of the woody plants on the border. It is pointed out that the effects of competition are negligible where the woody plants are less than six feet high. In general, insectivorous birds and mammals, and beneficial insects are more abundant in borders dominated by woody plants. Wind and water erosion control can be improved by dense woody borders. Field crop insect and mammal pests were more abundant in herbaceous borders. Nothing in this thesis caused this reviewer to change his opinion that shrub and tree borders properly placed and managed have advantages which farmers cannot afford to pass by.

This is a useful, detailed addition to our knowledge of field borders and related problems. Foresters dealing with farm woodlands and tree planting, wildlife technicians dealing with farm wildlife, soil conservationists, agricultural specialists in entomology, horticulture, and farm management will all find it useful in the eastern part of the country.

RICHARD M. MAY,
Soil Conservation Service.

Harvesting Timber Crops. By A. E. Wackerman. 437 pp. Illus. McGraw-Hill Book Co., New York. 1949. $5.

This book fills a long recognized need for a text which treats the field of logging, not as an independent separated procedure, but as a definite part of forestry; one in which the harvesting of timber is considered, and rightly so, as the principal forestry operation. As the author says, ". . . the culmination of all forestry effort is the mature tree. It has been grown for the purpose of creating a valuable commodity but its value can be realized only when it is harvested."

That the book has a refreshingly new approach may be gathered from the title. The material presented by Prof. Wackerman is carefully written to describe the principles involved in the harvesting operations.

The text is divided into four parts. The first is devoted to analyzing the relation of harvesting to forestry, reviewing the history of harvesting all timber crops, tracing the development of present day methods, planning a modern harvesting operation, and describing the various provisions for labor. Part II covers the selection of trees to cut and preparation of trees for removal, which describes the felling, bucking, hewing, riving or peeling operations necessary for various products. Part III, movement of products from the forest, deals with the transportation phases of harvesting which are given much attention because of the large proportion of the total cost that is involved. Part IV is a discussion of the organization of operations, scaling and measurement of timber products, and cost control and records. A final chapter on regional harvesting practices prepared by seven outstanding men, each an authority in his region, is unique in that it is more than the usual outline of skidding and hauling methods. Each of the contributors has written a short, though complete discussion of the forest, the labor supply, felling and bucking methods, bunching and skidding, loading, transportation, operational organization, and nature of the cutting operations within his respective region. Through these discussions the reader will learn much of the conditions in regions other than that with which he may be familiar.

Diagrams, photographs, and tabular material are adequate throughout the book and will be of great assistance to the student. Nearly every harvesting method, principle, or piece of equipment described in the text is illustrated. The subject of logging, probably more than any other in forestry, depends upon visual aids for successful presentation and Wackerman's book is outstanding in this respect.

One of the best features of the book is the logical arrangement with which the various phases of harvesting are covered. The reader is carried from one step to another without perceptible loss of harmony just as though he were following a tree from its selection for cutting until its arrival at the mill. At the same time however, Wackerman has made a comprehensive analysis of each of the harvesting operations, presenting many detailed explanations and illustrations which adequately cover the many ramifications of logging methods throughout the country. His ability to make a complete analytical study of each operation and yet keep the trend of thought progressing smoothly will greatly increase the student's knowledge of harvesting and its relation to forestry.

Part IV is particularly distinctive. The coordination of the various phases of harvesting is described in detail. In the chapter on harvesting organization the importance of a balanced operation is stressed, along with the effect of this balance, or lack of balance, upon physical and economic efficiency. Further discussion then describes the general organizational systems under different types of operations from the "large-scale concentrated" to the "small scattered." Chapter 17, on costs and records would bear reading by all persons having any part of the supervising of timber harvesting. Wackerman's searching analysis of the cost factors in any operation, how they should be recorded, studied, and controlled might profitably be considered by many going concerns.

CHARLES O. MINOR,
Louisiana State University.

❦ ❦ ❦

History of the White Pine Industry in Minnesota. By Agnes M. Larson. 432 pp. Illus. University of Minnesota Press, Minneapolis, 1949. $7.50.

Minnesota's first commercial relations with the civilized world began with the taking of fur by the Frenchmen, Radisson and Grosielliers, to Montreal about the middle of the seventeenth century. The fur trade made no lasting contribution to the economic life of the region. It gave way to the lumber industry and by 1850 no longer held first place.

The growing lumber industry required a stable agriculture to supply food for its hungry loggers and millhands. It in turn furnished the lumber necessary for building the cities and farmsteads of the Middle West. Both lumbering and farming required railroads for their continued development. Lumber furnished the foundation for the economic development of Minnesota. For at least five decades the white pine industry was *the* lumber industry in Minnesota. It is appropriate that Dr. Larson's *History of the White Pine Industry in Minnesota* be published in 1949, Minnesota's territorial centennial year.

The white pines, *Pinus strobus*, played an important part in the development of the northern part of the United States. In New England, New York, northern Pennsylvania, Michigan, Wisconsin, and Minnesota it was for decades a most important product. In Minnesota where white pine closely approaches the prairie, white pine made its last great contribution. The history of the white pine industry in Minnesota is a continuation of its history in the states to the east. In particular, Minnesota's white pine logging history cannot be separated from that of those areas in Wisconsin draining into the Mississippi River.

Minnesota possesses the headwaters of three great river systems. All provided log transportation to mills, and transportation of lumber in consuming areas. To the south flowed the Mississippi and along the Mississippi were towns and cities that had been receiving lumber by water from more eastern areas. To the north flowed the Red River eventually to play its part in taking logs and building materials into that rich farming area, the Red River Valley lying on the boundary of Minnesota and North Dakota and extending into Manitoba. To the east flowed rivers into Lake Superior, head of the Great Lakes navigation, to consuming and wholesale centers further east including Buffalo and Tonawanda, N. Y., and Chicago.

Minnesota's first commercial sawmill at Marine on the St. Croix, equipped with a muley saw capable of cutting 5,000 feet per day, started operations on August 24, 1839. Other mills were established at nearby Stillwater.

The first commercial mill at the falls at St. Anthony (now a part of Minneapolis) started operations on Sept. 1, 1848. Around 1900 Minneapolis was to be the leading lumber market of the world.

In 1862 the railroads made a modest beginning in Minnesota. They first moved lumber into the fast developing farming areas to the west and south, and later, as the timber was cut from near drivable streams, were important in logging.

The number of sawmills in the state rapidly increased—207 in 1870, 234 in 1880, 317 in 1890, and 404 in 1900. Sawmill equipment was improved. In 1870 the average mill cut about 100,000 feet per day; in 1880, 200,000 to 250,000 feet per day; and in 1890 the larger mills were cutting 400,000 feet per day.

Mills were established in and near the pine forest area. In fact, Dr. Larson could have safely said that every city, town, and hamlet in the forest area of northern Minnesota played a part in the lumber industry.

Minnesota reached her peak in lumber production in 1899 with a cut of 2.3 billion feet. After that date the cut declined. The author quotes 58 million feet for 1932. The reviewer is naturally curious why she did not use the lower figure of 48.6 million feet for 1933, and why she does not say that since 1933 Minnesota's production has been increasing. The Forest Survey estimates an average cut of lumber in Minnesota for the years 1935-1944, inclusive, of 175 million board feet.

Dr. Larson estimates that 67.5 billion board feet were cut in Minnesota during the period 1839 to 1932. In contrast, the authors of U.S. D.A. Statistical Bulletin No. 68 *Forest Products Statistics of Lake States* estimate that 72.5 billion feet of lumber were produced in Minnesota during the period 1830-1935.

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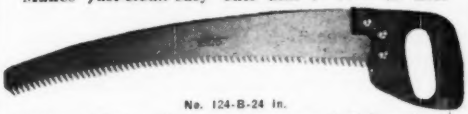

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Dr. Larson's book contains a wealtn of detail concerning personalities, life in logging camps, equipment in the woods and mills, transportation of logs and lumber, markets and marketing, and the operation of federal and state land and timber laws during the years she writes about. While her book concerns itself with the lumber industry she does not neglect to point out the relationships between that industry and agriculture and transportation. She has made a substantial contribution to the history of forest products industries of the United States.

L. B. RITTER,
St. Paul, Minn.

❦❦❦

Trees of Mount Rainier National Park. By C. Frank Brockman. 49 pp. Illus. University of Washington Press, Seattle. 1949. 75 cents.

Visitors to Mount Rainier now have an attractive and authoritative handbook to help them identify, and learn interesting facts about, each of the many trees of the park. It is written by one who knows the forests of Mount Rainier from years of residence as park naturalist. Mr. Brockman, the author, is now professor of dendrology at the College of Forestry of the University of Washington.

In this well-printed paper-covered pamphlet we are told that 77 percent of Mount Rainier National Park is forested, including the subalpine forests and the old burns as well as the densely wooded lower slopes. Four zones are described in simple, nonecological terms, the lowland forest, the intermediate forest, the subalpine forest, and the timber-line forest.

Most of the text is devoted to a tree by tree description of the 16 conifers and 12 broadleaf species that occur in the park. Photographs on an inch-square grid of foliage and cones make identification easy. With the simple clear description of each tree its regional and local distribution within the park is given, together with interesting bits of information on its silvical characteristics and uses.

The 12 broadleaf species, all minor members of the park's flora, are treated more briefly than the conifers. The list might have been longer had the author included some of the bushy species that are commonly classed as trees, like vine and dwarf maple.

The nomenclature follows closely that in the printed Forest Service check list, but does not embody all the forms proposed in the mimeographed 1944 edition, such as redcedar (one word), hyphenated Douglas-fir, and *Abies procera* for noble fir, perhaps because these changes have not yet had final official sanction.

A handy 4-page key makes it easy for a layman to run down any tree he may encounter in the park, provided he has a specimen of fruit and foliage in hand.

This little dendrology book is in every way very well done; only a meticulous critic could find any errors in it. Many visitors to Mount Rainier will read it, enjoy their stay in the mountain forests all the more for it, and come away better acquainted with western Washington's rich assortment of forest trees.

THORNTON T. MUNGER.

❦❦❦

Virginia Forest Resources and Industries. Misc. Pub. No. 681, Forest Service, U. S. Dept. Agric. 64 pp. Illus. Supt. of Documents, Washington 25, D. C. 1949. 50 cents.

"Forests rank high among Virginia's rich and varied natural resources. They have a significant influence on the welfare of agriculture, industry, employment, water supplies, game and fish, and recreation. But their contribution to the people of the State is only a fraction of what it could be under better forestry and closer utilization." Such is the conclusion reached by Ronald B. Craig, forest economist for the Southeastern Forest Experiment Station, who prepared this publication from basic information obtained by the Forest Survey.

Although the publication contains a wealth of information about Virginia's forest resources, forest industries, and growth and drain relationship, and although it fills a very definite need for reliable factual information, its value is reduced by the long delay between original preparation of the manuscript and final printing and distribution. Prepared as it was in 1946 to cover data obtained in the 1940-1945 period, its appearance is now four years behind time. It is extremely doubtful if the numerous revisions and changes demanded by Washington added much of value to the original, whereas it is quite certain that some of its worth and usefulness has been dissipated by the passage of time. One year to prepare and one year to print would seem to be a useful motto for the Forest Service to adopt.

The contents include descriptions of Virginia's broad physiographic provinces; social and in-

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This book is a complete rewriting and revision of Brown and Panshin's well known *Identification of the Commercial Timbers of the United States.* It will be followed by a second volume dealing with the physical, mechanical, and chemical properties of wood. Together the volumes will constitute a complete treatment of the subject matter of wood technology. Vol. I covers factual information on the structure, identification, general properties, uses, and major defects of commercial wood in the United States. All material has been brought up to date, clarified, and presented in more logical sequence.

HARVESTING TIMBER CROPS

By A. E. Wackerman, Duke University. *American Forestry Series.* 437 pages, $5.00

A text covering all phases of harvesting, from preliminary considerations, involved in planning and preparing for the actual harvesting steps, to cost controls and records. The final chapter, devoted to regional harvesting practices, was prepared by seven contributors, each an expert in his region. The subject of timber harvesting is treated as an integral part of forestry, rather than as an independent procedure. The author covers the harvesting of all important forest products such as saw logs, pulpwood, poles, ties, and veneer blocks. Throughout, the treatment is more analytical than descriptive. The illustrations are outstanding.

FARM WOOD CROPS

By John F. Preston, formerly chief of Forestry Division, Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C. *American Forestry Series.* 302 pages. $3.75

A textbook for usual courses in farm forestry in colleges of agriculture. Employs a direct and practical approach and does not treat dendrology and silviculture from an academic point of view. It is a technical guide to the development of a farm woodland enterprise integrated with the farm business. It presents the farm economic angles of forestry and the forestry techniques needed in the initial stages of woods management. It shows why the farmer should grow wood as a farm crop, and, after he has decided to do it, how to take the first steps in farm woodland management.

FOREST MENSURATION

By H. H. Chapman and Walter H. Meyer, Yale School of Forestry. *American Forestry Series.* In press

A practical text for forestry students and a field manual for foresters, dealing with the measurements of trees and timber, and of harvested lumber and other products. The material is entirely up to date and the authors deal first with forest products, tracing from cause to effect; the next step is to study the individual logs or bolts; then a combination of their contents into volume tables for average trees by diameter, height, and form classes. Each chapter contains a list of selected references to published and accessible material on the subject discussed.

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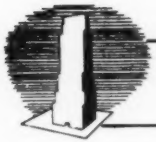

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dustrial conditions; land use; forests; timber and cordwood volumes; forest industry utilization, employment, and waste; increment and drain; and opportunities for increasing the timber resources. Pictures, graphs, charts, and maps amply illustrate the entire publication, and almost tell the story in themselves. For those who desire additional and more detailed data they are provided in numerous tables. Altogether it is a well prepared and factual source of information.

Principal interest of the reader naturally will center on the increment and drain relationship, for that is the key to what is happening to the forests. The overall figures for the state are at first glance encouraging for, in spite of heavy war-time demands, the sawtimber volume increased 7 percent and the cordwood volume increased 11 percent during the 6-year period. However, in the words of the writer, "Less reassuring are some of the details of this increase." He then goes on to explain two points. First, although the net change in softwood volume for both sawtimber and cordwood was negligible, actually there was a considerable deficit in the more desirable species that was compensated for primarily by a substantial increase in the much less desirable Virginia pine—hardly a fair exchange. Second, although the softwoods provide approximately two-thirds of both sawtimber and cordwood demands, it was the hardwoods that provided all the sawtimber gain and 80 percent of the cordwood gain—and much of this in undesirable species. All of which points up the fact that industries now cutting pine, notably in the Piedmont, may be forced in a relatively short time to switch to hardwood or go out of business.

Though there can be little argument with the facts and figures as presented, there can be differences of opinion concerning some of their suggested ways and means of increasing quantity and improving volume, notably with the recommendation for "public control of cutting and other forest practices on private land."

Other recommendations for a greatly expanded state forestry personnel, additional fire protection, and more research have already been partially met, but it is unlikely that they will be developed to the extent suggested.

Taken all in all, this publication is by far the best available on Virginia's forest resources.

WILLIAM E. COOPER,
Virginia Forests, Inc.

Hydrology. By C. O. Wisler and E. F. Brater. 419 pp. Illus. John Wiley & Sons, Inc., New York. 1949. $6.

With increasing demands for water resources, foresters and land managers recognize a need for increasing their knowledge of hydrology, a science that deals with "the depletion and replenishment of water resources, the transportation of water through the air, over the ground surface, through the soil and rock strata on the earth." Watershed management for municipal water supplies and for recreational use of streams for fishing; land use planning for flood control, drainage, irrigation; in fact most problems that concern the use and supply of water—all require at least a working knowledge of this science.

Watershed management is practical applied hydrology, in that it is concerned with the effect of vegetation, trampling, fire, and other land use practices on stream flow. Many practical problems confronting foresters today can be solved only in terms of hydrology. A typical problem, for instance, is the increase in standing water on flat moist sites following heavy cutting and fire. Here normal transpiration has been greatly altered. Ten to twenty more inches of water formerly removed by trees each year now remain on the land to be disposed of otherwise. Forest-streamflow relations and all types of land use effects on runoff can be explained as hydrologic processes. Foresters may be surprised to read that ordinarily it is the nature of the openings existing in the surface one-fourth inch of soil that determine infiltration capacity (the maximum rate at which a soil in any given condition is capable of absorbing water). It is quite conceivable that changes in the composition and condition of the stand brought about by cutting, trampling, and burning, will all alter this top-one-fourth inch of soil to a significant amount.

Foresters today are watershed managers but few of them have had formal college courses in the field of water resource management. Those who are looking for orientation in this field will welcome a text that recognizes that knowledge of hydrology is a working tool, "of value not only in the field of engineering but also in forestry, agriculture and other branches of the natural sciences." Both authors have participated at one time in Department of Agriculture flood surveys, and the junior author has been associated with the U. S. Forest Service in watershed management research.

Because it is one of the "newest of the natural sciences in which new theories are being constantly advanced," considerable evolution of the science of hydrology has taken place since the earlier books on the subject were published. The authors have brought the subject up to date. The distribution graph, the unit hydrograph, the theory of infiltration, and other recent developments are presented in detail. Recent researches on the total effects of forests on stream flow are also summarized.

Instead of beginning with a detailed discussion of rainfall, evaporation, etc., and thus leading up to stream flow, this usual order of presentation of the subject has been changed to advantage. After only a brief introduction to the components of the hydrologic cycle and their relations, the authors proceed at once to the subject of stream flow. Their purpose in doing this is of course to acquaint the reader sufficiently with the nature and diversity of the problems of interpreting the stream hydrograph, so that he can "better appreciate the need for a knowledge of precipitation, evaporation, infiltration, and related subjects which might otherwise be of little interest in themselves."

The chapter on infiltration—the first to appear in any textbook of hydrology—is followed by a thorough discussion of ground water. This sets the stage for a very logical presentation of the subject of runoff in terms of runoff from small plots, then small watersheds, and finally large watersheds. This procedure helps the reader to understand how water gets into the stream channels.

In writing a concise text for college use, the authors have had to treat some subjects briefly and there are possibly a few omissions. However, numerous references are supplied and anyone wishing to orient himself within any special phase of the subject can use this text as a guide to further study.

All in all, the authors have gone a long way toward interpreting watershed management and the land use aspects of hydrology—much further than other writers on the subject. For land managers and foresters who seek an understanding of the concept of hydrology this book opens the door to an intensely interesting and fruitful field of adventure.

CHARLES R. HURSH,
Southeastern Forest Experiment Station.

Current Literature

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The New York State College of Forestry

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FRANCES FLICK, *Library, U. S. Department of Agriculture*

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Control of Weeds in Conifer Nurseries by Mineral Spirits. By J. H. Stoeckeler. 23 pp. Lake States Forest Expt. Sta., St. Paul 1, Minn. 1949. Sta. Paper No. 17.

Correction of Soil Acidity in Conifer Nurseries. By J. H. Stoeckeler. 1 p. Lake States Forest Range Expt. Sta., St. Paul 1, Minn. 1949. Tech. Notes No. 319. Mimeog.

Development of the Lodgepole Pine Types in the North-Central Interior Following Selective Cutting for Railroad Ties. By A. R. Fraser. 8 pp. British Columbia Forest Serv., Victoria. 1949. Research Notes No. 16.

Exotic Trees in the Coastal Region of British Columbia. By E. H. Garman. 14 pp. British Columbia Forest Serv., Victoria. 1949. Research Notes No. 15.

Winter Injury and Recovery of Conifers in the Upper Midwest. By J. H. Stoeckler and P. O. Rudolf. 20 pp. Lake States Forest Expt. Sta., St. Paul 1, Minn. 1949. Sta. Paper No. 18.

Wood Technology and Utilization

Exploratory Tests on Machining and Related Properties of Fifteen Tropical American Hardwoods. By E. M. Davis. 5 pp. U. S. Forest Products Lab., Madison, Wis. 1949. R1744. Mimeog.

Exudation of Pitch and Oils in Wood. By F. L. Browne and R. C. Rietz. 11 pp. Illus. U. S. Forest Products Lab., Madison, Wis. 1949. R1735. Mimeog.

Facts About the Lumber You Sell. By O. H. Schrader. 35 pp. Illus. National Lumber Manufacturers Assoc., Washington 6, D. C. 1948. $2.

The Grinding of Hardwoods; Experiments on Eastern Cottonwood, Yellow-Poplar, Sugar Maple, Black Tupelo, White Ash, Birch, and Sweetgum. By Axel Hyttinen and E. R. Schafer. 9 pp. U. S. Forest Products Lab., Madison, Wis. 1949. R1745. Mimeog.

Groundwood Pulping of Five Common Northeastern Farm Woodland Species. By E. R. Schaefer and Axel Hyttinen. 5 pp. U. S. Forest Products Lab., Madison, Wis. 1949. R1743. Mimeog.

Pulps and Corrugated Paperboards from Farm Woodland Chestnut Oak. By J. N. McGovern and others. 7 pp. U. S. Forest Lab., Madison, Wis. 1949. R1738. Mimeog.

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Utilization of Farm Woodlot Woods for Roofing Felt. By E. A. Anderson and E. R. Hrubesky. 10 pp. U. S. Forest Products Lab., Madison, Wis. 1949. R1739. Mimeog.

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Society Affairs

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Oregon State College,
Corvallis, Oreg.

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Bureau of Entomology and Plant Quarantine,
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CHARLES H. FLORY,
State Commission of Forestry,
Calhoun State Office Building,
Columbia, S. C.

WILLIAM B. GREELEY,
West Coast Lumbermen's Association,
4444 White-Henry-Stuart Building,
Seattle 1 ,Wash.

CLARENCE S. HERR,
Woods Department,
Brown Company,
Berlin, N. H.

HENRY CLEPPER, *Executive Secretary*
825 Mills Building,
17th Street at Pennsylvania Avenue, N. W.
Washington 6, D. C.

RICHARD E. MCARDLE,
Forest Service,
U. S. Department of Agriculture,
Washington 25, D. C.

DEWITT NELSON,
Division of Forestry,
Department of Natural Resources,
Sacramento 14, Calif.

JOHN W. SPENCER,
U. S. Forest Service,
Post Office Building,
Denver 2, Colo.

What Professional Fields Should the Society Represent?

At its last three meetings, the Council of the Society has worked upon a referendum that will enable our members to answer this question. The referendum will soon be in your hands. It is one of the most important upon which you have yet been called to cast a vote. It goes to the heart of the question: Just who and what are we as a body of professional men?

The Council makes no recommendation on the professional base of Society membership. Its obligation, as we see it, is to draft several alternatives which fairly cover the range of thinking among our members and submit these alternatives to the direct choice of the electorate. Society members will vote on three alternatives. The Council has asked me to assume the role of prophet and attempt to indicate what effect the adoption of each alternative may have upon the future of the Society.

The issue started from criticisms that the Society, in its qualifications for members, is interpreting too narrowly the professional attainments we should represent. Membership is now restricted to men of professional training and experience in the management of forest land and utilization of its resources. Grazing, recreation, wildlife management or water conservation are recognized in professional qualifications only when conducted on lands whose principal crop is trees (or chaparral in the case of water conservation) and when a knowledge of professional forestry is part of a candidate's equipment.

Our ranks include many men whose training and work have dealt largely with range management, with or without trees. From this group comes a demand that professional training or experience in range management, regardless of cover types, be accepted in Society recruiting on all fours with forestry. Other members would liberalize our professional base to include all forms of wild land management and use on a parity with forestry. They would open our doors to professionally trained men in range, water, wildlife, and soil management or conservation without regard to cover types. Forest management, for Society purposes, would thus be interpreted as extending to all wild land resources and uses, whether in the shade of a tree or as bare as the Mojave Desert.

No one, I believe, expects that the professional interests of these additional wild land groups would all be merged in the S.A.F. They now have, and will undoubtedly expand, technical societies in their own more restricted fields. Nor

is the change proposed with the purpose of building up our Society numerically. Henry Clepper estimates that putting all wild land professions on parity in our admissions might bring in 170 or 180 new members now and possibly an additional yearly intake of 15 or 20. The numerical influx would not be very significant from any standpoint, in comparison with our present 6,200 members and yearly net increase of about 500.

The main purpose of liberalization, as I see it, would be to aid the correlation of all phases of wild land management; to support the principle of multiple use and extend its application; and to strengthen the conservation of wild land resources as a whole in professional thinking and in public policies. The change would also encourage the type of professional training now being developed by some western universities like the Utah School of Forest, Range and Wildlife Management.

The Council offers three choices for your vote:

1. ***Retain*** **our present membership qualifications without change.**

2. ***Liberalize partially*** **to the extent of accepting equivalent professional training in any form of wild land management as a satisfactory qualification; provided the new member has had 25 percent of accredited school training in forestry or 3 years' experience in any form of wild land management** ***and a demonstrated interest in forestry.***.

3. ***Liberalize completely*** **by accepting members with no training or experience in forestry but with its equivalent in some other form of wild land management.**

In my judgment, the adoption of neither No. 2 nor No. 3 would materially change the present character or major interests of our Society. We have lots of members now whose active interest lies in types of wild land management other than forestry and whose voice is welcomed in Society affairs and publications. S.A.F. itself has, from its birth, been devoted broadly to all-round conservation of natural resources; and there is every reason to believe it will continue to be. Witness its recent action in respect to the unreserved public ranges. With the continuing numerical dominance of foresters in our membership and the current progress of forestry in many new directions, it is impossible for me to visualize any significant dilution or change in the main activities of the Society, however the voting goes on this referendum.

The real choice, as I see it, concerns the long-range trend in Society policy and influence.

If we want a Society that will concern itself more strictly with forestry as time goes on and the professional interests keyed into forestry, we should vote for No. 1.

If we want a Society that is to be active and influential in the conservation and integrated management of all natural resources, we should vote for No. 2 or No. 3.

If we want to carry authority and weight in this broad field of conservation with able articles in the JOURNAL and effective Divisions dealing with all phases of wild land use, I would say vote for No. 3.

Sympathetic interest only and general support for these other fields of natural resource conservation, rather than forceful leadership, would indicate a vote for No. 2.

I don't think we should vote on this basic question with the purpose simply of being good fellows. We should not invite "in" the range men just to stand on the side lines and watch us mark timber. If we liberalize qualifications for membership, it should be because we want this broader professional association and collaboration. We should want to hear these men in

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the JOURNAL and in national and Section meetings; and should be ready to understand and support their interests as we want them to understand and support ours.

The Council makes a strong plea that every member give some real thought to this problem and *then vote his convictions.*

W. B. GREELEY,
Member of the Council.

Announcement of Nominations for President and Council

At the time of going to press with this issue of the JOURNAL, the following nominations for the office of president and for membership on the Council had been received. Calls for nominations had been published monthly during the year in this section of the JOURNAL.

The regular biennial election will be held December 10. A president, vice president, and nine other members of the Council will be elected for two year terms 1950-1951.

Each voter will have an opportunity to ballot on all nominees. Candidates for the office of president are voted on separately; the candidate who receives the highest vote is declared elected president, and the candidate who receives the next highest vote is declared elected vice president. The nine remaining Council members are elected in accordance with the system of proportional representation.

For President

Charles F. Evans, U. S. Forest Service, Atlanta, Ga. (Southeastern Section.)

C. S. Herr, Brown Company, Berlin, N. H. (New England Section.)

For the Council

LeRoy D. Arnold, Indian Service, U. S. Department of Interior, Washington 25, D. C. (Washington Section.)

Lloyd P. Blackwell, Louisiana Polytechnic Institute, Ruston, La. (Gulf States Section.)

F. H. Brundage, Harbor Plywood Company, Portland, Ore. (Columbia River Section.)

F. H. Claridge, Department of Conservation and Development, Raleigh, N. C. (Appalachian Section.)

D. B. Demeritt, Dead River Lumber Company, Bangor, Maine. (New England Section.)

J. Whitney Floyd, Department of Forest Management, Utah State Agricultural College, Logan, Utah. (Intermountain Section.)

Stanley G. Fontanna, Department of Conservation, Lansing, Mich. (Central States Section.)

Ralph W. Hayes, Louisiana State University, Baton Rouge, La. (Gulf States Section.)

Frank H. Kaufert, School of Forestry, University of Minnesota, St. Paul, Minn. (Upper Mississippi Valley Section.)

C. Otto Lindh, U. S. Forest Service, Albuquerque, N. Mex. (Southwestern Section.)

E. W. Littlefield, Division of Lands and Forests, New York Conservation Department, Albany, N. Y. (New York Section.)

Gordon D. Marckworth, College of Forestry, University of Washington, Seattle, Wash. (Puget Sound Section.)

Richard E. McArdle, U. S. Forest Service, Washington, D. C. (Washington Section.)

Stuart Moir, Western Forestry and Conservation Association, Portland, Ore. (Columbia River Section.)

Elwood B. Moore, N. J. Conservation Department, Trenton N. J. (Allegheny Section.)

DeWitt Nelson, Department of Natural Resources, Sacramento 14, Calif. (Northern California Section.)

Earl Porter, International Paper Company, Mobile, Ala. (Southeastern Section.)

Russell Watson, Manistique, Mich. (Wisconsin-Upper Michigan Section.)

Announcement of Nominations to the Grade of Fellow

At the time of going to press with this issue of the JOURNAL, the following nominations for the grade of Fellow had been received. Calls for nominations to this grade had been published monthly during the year in this section of the JOURNAL.

Fellows are not elected by the membership at large, but by a board of electors which consists of all present Fellows and the present Council. (A Council member who is also a Fellow has but one vote.)

Nominations Received

Frederick S. Baker, California.
Fred H. Brundage, Oregon.
John H. Foster, New Hampshire.
Evan W. Kelley, Montana.
Royal S. Kellogg, Florida.
E. I. Kotok, District of Columbia.
Woodbridge Metcalf, California.
Lee Muck, District of Columbia.
Dana Parkinson, District of Columbia.
W. B. Rice, Utah.
Stephen N. Wyckoff, California.
Ellwood Wilson, Quebec.
E. A. Ziegler, Florida.

Consulting Foresters Asked to Apply For Society Listing by November 1

Consulting foresters who wish to be included in the S.A.F. List of Consulting Foresters to be published in the January 1950 JOURNAL OF FORESTRY should notify the S.A.F. office of their specializations and territory prior to November 1, following the form used when the list was last published, in March 1949.

Compilation of *Foresters' Field Manual* Begun

At its June 1949 meeting the Council decided to proceed with the compilation of a *Foresters' Field Manual*, as was recommended by a committee which explored the subject and reported to the Society at the Minneapolis meeting in December 1947 (see the JOURNAL OF FORESTRY for March 1948, pages 201-205).

In addition the Council authorized the appointment of a three-man committee to supervise compilation of the manual. And the executive secretary was instructed to negotiate for the part-time services of a professional forester with some knowledge of this field and with suitable editorial experience.

The three-man supervisory committee has been appointed. Its personnel represent a diversity of professional interests and all are geographically near enough to Washington, D. C., to permit ready consultation. The membership is as follows:

Chairman, E. W. Littlefield, Division of Lands and Forests, Albany 7, N. Y.

James G. Osborne, biometrist, Forest Service, U. S. Department of Agriculture, Washington 25, D. C.

William Maughan, Cary Lumber Company, Box 1491, Durham, N. C., formerly professor at the Duke School of Forestry and manager of Duke Forest.

President Martin has also appointed R. D. Forbes, R.D. 1, Ambler, Pa., as part time editor to work under the supervision of the committee. Mr. Forbes has had 36 years' experience in state, federal, and private work, in 22 states.

In addition to the supervisory committee, 19 subject matter committees have been authorized. It will be the duty of these subject matter committees to assemble the material to be included in the manual. As soon as these committees have been organized and given instructions, their personnel will be announced in the JOURNAL.

In the meantime, any forester who may have suggestions for this project is invited to send them to Mr. Forbes. This is a Society project and all members are cordially invited to interest themselves in it.

HENRY CLEPPER,
Executive Secretary.

Coming Events

Association of State Foresters

The annual meeting of the Association of State Foresters will be held in Hot Springs, Arkansas, October 5-7. Fred Lang, state forester, Little Rock, Ark., is in charge of arrangements.

American Forestry Association

The annual meeting of the American Forestry Association will be held October 10-13. Primarily a field meeting, those in attendance will convene at Wheeling, West Virginia, for a luncheon and trip through Oglebay Park. On October 12 there will be a trip to the Muskingum Watershed Conservancy District in Ohio, with a night stopover in Akron. On the 13th trips have been scheduled to Louis Bromfield's Malabar farm and the soil conservation research station at Wooster.

Canadian Society of Forest Engineers

The annual meeting of the Canadian Society of Forest Engineers will be held in Toronto, Oc-

tober 24-26. Murray Morison, Department of Lands and Forests, Toronto, is chairman of the Meeting Committee.

Central States Section

The annual meeting of the Central States Section will be held at Cairo, Ill., October 27-29. Reservations should be made through Don Winters, Box 134, Murphysboro, Il.

Northern California Section

The Northern California Section will hold its annual meeting in San Francisco, on December 3, at the Sir Francis Drake Hotel.

The Section secretary is Rudolph Grah, 23 Forestry Building, University of California Berkeley, 4.

A.A.A.S.

The annual meeting of the American Association for the Advancement of Science will be held in New York City, December 26-31.

Hotel reservation blanks and information about the section programs may be obtained from the association headquarters, 1515 Massachusetts Avenue, N. W., Washington 5, D. C.

Elections to Membership

Affiliate

Baker, E. E., Wash.
Burnham, R. M., S. D.
Crocker, F. M., Me.
Hojem, L. R., Wash.

Associate

Bodine, L. V., Minn.
Kibbey, M. B., Calif.
Shenefelt, R. D., Wis.

Junior

Anderson, R. B., Calif.
Barick, F. B., Pa.
Blair, J. K., Wash.
Bober, E. J., Ohio
Carlson, G. A., Wis.
Clarke, E. H., Tenn.
Cowan, W. F., Tenn.
Cross, J. K., Miss.
Decker, T. P., Wis.
Desmond, M., Ga.
Dolhonde, P. E., La.
Dwyer, W. W., Mass.
Ebert, J. B., N. J.
Ehly, A. E., Wis.
Foster, H. J., Ga.
Goodwin, A. L., La.
Grigsby, H. C., Miss.
Hall, C. R., W. Va.
Henthorne, R. W., Ore.
Hernandez-Agosto, M. A., P. R.
Hortin, R., N. C.
Hovde, S. B., Wis.
Johannsen, W. B., Ore.
Kelly, P. T., Ark.
Korb, H. W., Jr., S. C.
Lovette, J. M., Tenn.
Marlin, C. B., N. C.
Massie, G. E., Ill.
McComb, F., Wash.
Merrick, G. D., D. C.
Miles, D. J., La.
Morris, L. H., Ore.
Morrison, E. W., N. Y.
Nousianen, A. D., Idaho.
O'Leary, J. D., Ark.
Olson, D. F., Jr., N. C.
Orum, R. M., Del.
Palmer, D. B., Pa.
Pearson, H. G., Ore.
Pfeifer, R. E., Mich.
Piha, L., Calif.
Shoub, J. L., S. C.
Sigler, C. C., La.
Stephens, W. D., Fla.
Stoltenberg, C. H., Calif.
Terrell, N. K., Fla.
Thompson, T. A., Minn.
Voris, C. R., Ore.
Wardell, G. D., Ore.
Wildes, H. C., Ga.
Willingham, J. W., Fla.
Yancey, T. E., Va.

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Ahlskog, H. E., Mont.
Alexander, L. B., Ore.
Anderson, C. G., Mo.
Anderson, M. V., Utah
Barber, P. E., N. Y.
Baudendistel, M. E., Mont.
Beal, R. P., Idaho.
Bishop, A. H., N. Y.
Blumenstein, R. R., D. C.
Bowman, H. F., Calif.
Briggs, A. E., Idaho.
Brown, W. J., S. C.
Bryan, P. H., Ga.
Bunch, A. L., Idaho.
Callender, W. C., Ga.
Carlson, L. H., Utah
Clark, E. W., Ark.
Clave, W., N. Y.
Cox, E. L., Utah
Crossley, D. I., Canada.
Dargan, L. M., S. C.
Dercum, Max., Colo.
Deyton, J. M., N. C.
Doll, G. B., Nev.
Easterbrook, P. W., Idaho.
Eaton, F. L., Mont.
Fales, R. B., N. Y.
Field, D. E., Mont.
Fisk, M. C., N. Y.
Flint, A. A., Mont.
Foster, W. L., S. C.
Fowler, C. W., Calif.
Francis, E. H., N. Y.
Furbush, P. B., Calif.
Gangle, L. C., Ore.
Gervais, L., Ore.
Gill, C. E., Va.
Grote, F. R., Ark.
Haddock, P. J., N. Y.
Harpp, N. H., N. Y.
Harrison, O. A., Utah.
Heit, C. E., N. Y.
Heller, R. C., Md.
Hellmers, H., Calif.
Hill, H. D., Mont.
Holcomb, H. W., N. Y.
Huff, J. L., S. C.
Hurd, R. M., Idaho.
Iler, J. C., Mont.
Jansson, J. R., Mont.
Johnson, F. W., Mont.
Julander, O., Utah.
Koen, J. T., S. C.
Kooch, J. G., Idaho.
Lafferty, G. E., Idaho.
Lannan, P. T., Jr., S. C.
Larsson, O. G., Canada.
Lathrop, H. F., S. C.
Lukens, S. M., Mont.
MacAndrews, A. H., N. Y.
MacLulich, D. A., Canada.
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Matthew, L. S., Mont.
McCasland, H. J., N. Y.
McDonald, C. H., Mont.
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Meyers, F. W., Mo.
Moore, F. S., Idaho.
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Neff, G., Mont.
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Noble, M. E., Utah.
Ohlman, R. G., N. Y.
Ohman, O., N. Y.
Park, R. H., Utah.
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Powers, F. E., Idaho
Poyner, N. E., Idaho.
Price, H. H., Utah.
Richmond, P. B., N. Y.
Richwine, L. L., Idaho.
Robertson, F. H., Fla.
Robinson, L. D., Mont.
Romero, F. S., Utah.
Ruff, F. J., Ga.
Russell, A. P., S. C.
Russell, D., Idaho.
Schapp, L. P., S. C.
Schramm, C. H., Mont.
Scott, H. R., S. C.
Sears, I. M., D. C.
Shea, P. H., Mont.
Simpson, C. W., Mont.
Sluzalis, L. L., Mo.
Smith, A. D., Utah.
Smith, E. L., Calif.
Snyder, S. M., Calif.
Somberg, S. I., S. C.
Squillace, A. E., Mont.
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Swofford, T. F., Miss.
Thomson, R. R., Utah.
Thompson, G. A., Mont.
Torgerson, A. R., Nev.
Twork, E. C., Mich.
Vitas, G., Ga.
Wadsworth, C. D., Wyo.
Walker, C. S., Calif.
Walker, G. A., D. C.
Ward, E. L., Canada.
Warren, G. E., S. C.
Waters, C. W., Mont.
Welton, E. W., Mont.
Wilde, K. E., Idaho.
Wiley, J., S. C.
Williams, R. K., Wash.
Wogensen, A. K., Wyo.
Woolley, C. A., Ore.
Youorski, J., S. C.

Honorary

Drury, Newton B., D. C.

Reinstated

Junior

Albee, L. R., S. D.
Brown, W. E., Calif.
Havel, J. F., S. C.
Howard, H. H., Miss.
Rand, C. W., N. H.

Announcement of Candidates for Membership

The following names of candidates for membership are referred to the membership for comment or protest. The list includes all nominations received since the publication of the September JOURNAL without question as to eligibility. Names, addresses, education, and endorsements are given. The names have not been passed upon by the Council. Important information regarding the qualifications on any candidate which will enable the Council to take final action with a knowledge of essential facts should be submitted before November 15, 1949. Statements on different men should be submitted on different sheets. Communications relating to candidates are considered as strictly confidential.

Allegheny

Junior Membership

Bedger, R. C., Farm Forester, Pa. Dept. of Forests & Waters, Lebanon, Pa.; Pa. State, B.S.F., 1949. V. A. Beede, H. H. Chisman, H. N. Cope.

Bell, J. F. L., Meadow River Lbr. Co., Rainelle, W. Va.; W. Va., B.S.F., 1949. A. W. Goodspeed, G. G. Marra, C. A. Myers, Jr.

Glattfelder, C. F., Sr. Forester, Pa. Dept. of Forests & Waters, Harrisburg, Pa.; Pa. State, B.S.F., 1949. F. T. Murphey, H. H. Chisman, V. A. Beede.

Hollen, D. E., Asst. Ext. Forester, Buckhannon, W. Va.; W. Va., B.S.F., 1949. A. W. Goodspeed, G. G. Marra, C. A. Myers, Jr.

Judy, D. T., Forester, Northfork Woods Products, Riverton, W. Va.; W. Va., B.S.F., 1949. A. W. Goodspeed, G. G. Marra, C. A. Myers, Jr.

Kelley, L. K., Research Asst., U.S.F.S., Parsons, W. Va.; W. Va., B.S.F., 1949. G. G. Marra, C. A. Myers, Jr., T. Holsoe.

Moore, R. C., Marlinton, W. Va.; W. Va., B.S.F., 1949. A. W. Goodspeed, G. G. Marra, C. A. Myers, Jr.

Van Gilder, Paul B., Forester, Northfork Wood Products Co., Riverton, W. Va.; W. Va., B.S.F., 1949. A. W. Goodspeed, W. C. Percival, G. G. Marra.

Woodrum, H. G., Box 334, Bellepoint, W. Va.; W. Va., B.S.F., 1949. G. G. Marra, G. A. Myers, Jr., T. Holsoe.

Appalachian

Junior Membership

Alvis, R. J., Soil Scientist, S.C.S., Newport News, Va.; N. C. State, B.S.F., 1949; Duke Univ., M.S.F., 1949. J. E. Hobbs, R. W. Graeber, J. L. Gray.

Brown, A. W., Forester, Draper Corp., Biltmore, N. C.; N. C. State, B.S.F., 1941. L. Wyman, J. E. Hobbs, E. Leysath.

Hunt, F. M., Forest Physiology Research, Duke Univ., Durham, N. C.; Duke, M.F., 1949. T. S. Coile, F. X. Schumacher, V. J. Rudolph.

Pfefferle, K. T., Forester, U.S.F.S., Covington, Va.; Colo. A & M., B.S.F., 1948. R. F. Haussman, Peter J. Hanlon, H. F. Barrett.

Vass, G. R., Tech. Forester, W. Va. Pulp & Paper Co., Summerville, S. C.; Purdue, B.S.F., 1946. R. E. Haynes, D. Y. Lenhart, J. J. Wiley, Jr.

Central States

Junior Membership

Boelter, A. H., Farm Forester, Mich. Dept. of Cons., Lansing, Mich.; Mich. College of Mining & Tech., B.S. (Forestry), 1943. Central States.

Guillaume, H. B., Park Mgr., Proud Lake Recreation Area, Dept. of Cons., Lansing, Mich.; Mich. State, B.S.F., 1941. A. C. Elmer, W. M. Beckert, R. L. Olmstead.

Killmer, K. D., Forester, Forestry Div., Dept. of Cons., Lansing, Mich.; Mich. College of Mining & Tech., B.S. (Forestry), 1940. Central States.

Love, W. B., Ext. Spec., Mich. State College, East Lansing, Mich.; Mich. State, B.S.F., 1937. J. N. Fields, L. E. Bell, K. Dressel.

Roach, B. A., School of Forestry and Cons., Ann Arbor, Mich.; Univ. of Mich., B.S.F., 1949. S. W. Allen, L. J. Young, S. T. Dana.

Columbia River

Junior Membership

Sims, J. R., Tallyman, Gardiner Lbr. Co., Gardiner, Ore.; Iowa State, B.S.F., 1947. G. B. Hartman, R. E. Getty, A. L. McComb.

Gulf States

Junior Membership

Froula, J. C., Park Rgr., Natchez Trace Parkway, Tupelo, Miss.; Univ. of Mich., B.S.F., 1949. W. F. Hamilton, A. K. Dexter, J. A. Tyler.

Hodge, J. S., Field Asst., Int. Paper Co., Natchitoches, La.; La. State, B. S. F., 1948. R. W. Hayes, A. B. Crow, C. O. Minor.

Riley, R. W., Park Rgr., Natchez Trace Parkway, Tupelo, Miss.; Colo. A & M., B.S.F., 1948. A. K. Dexter, R. M. Nonnemacher, J. S. Tyler.

Inland Empire

Junior Membership

Brown, R. R., Forester, Coeur d'Alene Natl. Forest, Coeur d'Alene, Idaho; Oregon State, B.S.F., 1947. P. M. Dunn, H. R. Patterson, G. H. Barnes.

Thompson, K. M., Forester's Aide, U.S.F.S., Grangeville, Idaho; Colo. A & M., B.S.F., 1949. J. C. Crupper, A. N. Cochrell, C. R. James.

New England

Affiliate Membership

Corliss, J. M., In Charge, Div. of Gypsy and Brown-Tail Moths Control, U.S.D.A., Greenfield, Mass. New England.

Associate Membership

Hosmer, W. A., Prof. of Bus. Adm., Harvard Grad. School, Boston, Mass. Harvard College, A.B., 1919; M.B.A., 1921. New England.

New York

Junior Membership

Castellani, W. J., 1656 E. 9th St., Brooklyn, N. Y.; N. Y. State, B.S.F., 1949. J. S. Illick, L. P. Plumley, R. M. Hutchinson.

Hollenbeck, G. N., Cape Vincent, N. Y.; N. Y. State, B.S.F., 1949. J. S. Illick, L. P. Plumley, R. M. Hutchinson.

Kick, L. W., Soil Scientist, U.S.D.A., Binghamton, N. Y.; N. Y. State, B.S.F., 1949. J. S. Illick, L. P. Plumley, R. M. Hutchinson.

Northern California

Junior Membership

Burton, R. E., Student, Univ. of Calif., Berkeley, Calif.; Univ. of Calif., B.S.F., 1949. L. N. Ericksen, R. F. Grah, E. Fritz.

Chase, J. M., Sales Repre., Dant & Russel, Ltd., Oroville, Calif.; Washington State, B.S. (Forestry), 1938. Northern California.

Denny, J. C., Dispatcher, Calif. Div. of Forestry, Redding, Calif.; Univ. of Calif., B.S.F. 1948. R. A. Cockrell, R. N. Colwell, P. M. Barr.

Ozark

Junior Membership

Campbell, D., Div. Forester, Int. Paper Co., Mobile, Ala.; N. Y. State, B.S.F., 1933. Reinstatement.

McDonald, D. R., Forester, Crossett Lbr. Co., Crossett, Ark.; Univ. of Fla., B.S.F., 1949. P. W. Frazer, H. H. Chamberlin, S. V. Sihvonen.

Shoulders, E., Forester, U.S.F.S., Harrison, Ark.; W. Va., B.S.F., 1947. J. L. Arend, R. A. Read, C. Messvage.

Southeastern

Junior Membership

Bliss, V. F., Tech. Repre., E. I. DuPont de Nemours, Atlanta, Ga.; Roanoke College, B.S. (Biology), 1947; Duke, M.F., 1949. C. F. Korstian, E. S. Harrar, A. E. Wackerman.

Owen, A. Z., Forester, U.S.F.S., Atlanta, Ga.; Univ. of Ga., B.S.F., 1938. J. B. Dahl, F. W. Rasor, H. Goodrich.

Stokes, R. A., Minneola, Fla.; Univ. of Fla., B.S.F., 1949. P. W. Frazer, C. G. Getlz, E. A. Ziegler.

Upper Mississippi Valley

Junior Membership

Lee, Robert E., Cruiser, North Star Tbr. Co., Duluth, Minn.; Univ. of Minn., B.S.F., 1948; M.F., 1949. A. P. Chapman, P. L. Huntley, N. J. McKenna.

Wisconsin-Upper Michigan

Junior Membership

Lutz, J. F., Wood Tech., U.S.F.S., Madison, Wisc.; Pa. State, B.S.F., 1942; Yale, M.F., 1949. Reinstatement.

The following have been Junior members for at least 6 years and are eligible for automatic advancement to Member grade. The Sections have certified them as actively engaged in forestry work and competent to represent the profession honorably and capably in the performance of their duties.

Central States

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Bucciarelli, F. V., Station A, Gorham, N. H.
Burr, M. H., Northeast Harbor, Me.
Carlisle, G. D., 237 Nowell Road, Bangor, Me.
Chapman, G. L., 152 Prospect St., Portland, Me.
Kidd, Walter J., Jr., 60 Coe Bldg., Bangor, Me.
King, F. C., Oquossoc, Me.
Knight, F. A., Sligo Road, Yarmouth, Me.
Merrill, W. J., Solon, Me.
Orsi, Charles R., Taunton, Mass.
Peabody, J. L., Wayland, Mass.
Proell, A. K., Keane, N. H.
Williamson, M. J., Northeastern Forest Exp. Sta., Alfred, Me.

Puget Sound

Brandes, R. A., Route 3, Port Angeles, Wash.
Brown, Harold E. D., U.S.F.S., Concrete, Wash.
Coskey, J. W., Box 159, Route 2, Centralia, Wash.
Erickson, H. D., College of Forestry, Univ. of Wash., Seattle, Wash.
Floe, Sanford M., Snider Rgr. Sta., Port Angeles, Wash.
Fraser, Don L., P. O. Box 750, Chehalis, Wash.
Fuller, R. L., Garfield at Jackson Sta., Port Townsend, Wash.
Goodyear, T. S., P. O. Box 794, Olympia, Wash.
Grell, H. V., % State Fire Hall, Shelton, Wash.
Klotz, A. C., Orillia, Wash.
Loners, Edwin, 3229 Alki Ave., Seattle, Wash.
Mills, Russell, % Canadian Forest Products, Englewood, B. C., Canada.
Murnen, E. J., 3015 N. Proctor St., Tacoma, Wash.
Olson, L. G., White River Lumber Co., Enumclaw, Wash.
Orell, B. L., Dept. of Cons., Olympia, Wash.
Ramstad, Robert M., Box 208, Elma, Wash.
Stier, R. E., St. Paul & Tacoma Lbr. Co., Tacoma, Wash.
Taylor, D. R., Box 221, Port Gamble, Wash.
Tinney, William A., 12002 1st Ave., N. W., Seattle, Wash.
Tullock, Charles E., Route 7, Box 70, Tacoma, Wash.
Wheeler, W. E., 421 Thomas St., Olympia, Wash.
Zach, L. W., P. O. Box 2982, Juneau, Alaska.

Southeastern

Bloomer, Denton H., Div. of Forestry, Cons. Dept., Grove Hill, Ala.
Bridges, W. J., Woods Mgr., Hollingsworth & Whitney Co., Mobile, Ala.
Marsh, Ralph, Jr., Union Bag & Paper Co., Townsend, Ga.
Steedley, Arthur G., U.S.F.S., McRae, Ga.
Vousden, J. A., Forester, Union Bag & Paper Corp., Homerville, Ga.

Upper Mississippi Valley

Nelson, R. K., Board Mill Supt., Wood Conversion Co., Cloquet, Minn.

Forestry News

Compiled by HENRY CLEPPER, *Executive Secretary*

Mann Gulch Fire, Helena National Forest, Montana

The Northern Region of the Forest Service, with headquarters in Missoula, suffered a tragic disaster on August 5, 1949. Ten smokejumpers and one ground patrolman lost their lives in the Mann Gulch fire on the Helena National Forest in Montana. Two more jumpers were injured so severely that they died in a Helena hospital the next day. Three members of the crew survived. The deceased, all experienced firefighters, were:

William J. Hellman, Joseph B. Sylvia, Eldon E. Diettert, Henry J. Thol, Jr., Leonard L. Piper, Stanley J. Reba, David R. Navon, Robert J. Bennett, Marvin L. Sherman, Philip R. McVey, Newton R. Thompson, Silas R. Thompson, and James O. Harrison.

The survivors are R. Wagner Dodge, Robert W. Sallee, and Walter B. Rumsey.

As far as can be determined, the fire was caused by a lightning storm on August 4. It did not become large enough for detection until 12:25 p.m. August 5, when it was sighted and reported by the Colorado Mountain Lookout 30 miles away. Its smoke was not visible to an earlier air patrol.

The day was hot and the humidity very low. The wind was brisk and varied in direction and intensity. A high burning index prevailed. The normal fire organization on the Helena was in place.

The fire was in the "Gates of the Mountains" wild area just east of the Missouri River, some 20 miles north of Helena. The country is steep and jagged, and is said to be one of the roughest places east of the Continental Divide. From the road's end, it is accessible by a six-mile motor boat trip, followed by a one-hour hike over rough terrain. The fuel type in which the fire occurred was Douglas-fir poles and mature timber with stringers of ponderosa pine and ground cover of fairly heavy grass.

These known conditions called for a routine smokejump. All 15 men landed safely about ½ mile from the fire, and cargo dropping completed the air operation at 4:10 p.m., August 5.

Ground Patrolman Harrison from Meriwether Station joined the crew. Led by Foreman Dodge the men worked their way down Mann Gulch toward the river. Dodge noted that the fire had crossed Mann Gulch and was burning towards them. Finding the planned route of travel cut off, they changed direction and climbed towards the top of the ridge north of Mann Gulch. After proceeding in this direction for a distance of approximately 2,000 feet, Dodge noted that the fire was so close that the only reasonable chance for escape was to set a retreat fire in the open grass about 200 feet or so below the top of the ridge. He told those nearest to him, who numbered at least eight, and the others only a few yards behind, what he was going to do and then started the retreat fire immediately. This fire in a few seconds had burned an area of one hundred feet square and was soon large enough to serve as an escape area, which he used as such. Dodge unsuccessfully instructed the men to come into the retreat burn with him. Instead, they attempted to gain the ridge or outrun the main fire. Only two, Rumsey and Sallee, were successful in saving themselves. They found retreat in a small rock slide. The fire roared over the slope at about 6 p.m. Survivors Dodge and Sallee reported the catastrophe to base camp about 9 p.m. A rescue crew, including doctors, was quickly dispatched. Search and evacuation operations were directed by Regional Forester Hanson. Dodge remained on the fire until all bodies were found. The last one was flown out by helicopter at about noon, August 7.

Commenting on the facts which have been verified in connection with the fire, Regional Forester P. D. Hanson said, "The jumping operation was considered by our men to be of a routine nature and as such was successfully executed. The men landed about one-half mile from the fire in an area selected by experienced men. The jumpers then proceeded according to plan for about two hours before critical conditions prevailed.

"The foreman used excellent judgment in seeking refuge on the grass-covered hillside which offered the best chance for safety from the onrushing fire which developed quickly and unexpectedly."

Grieved and saddened over the catastrophe, Hanson said, "Control of nearly every fire is a hazardous undertaking during critical fire weather, yet we must plan and make the attack. We make it a practice in each case to calculate probabilities of fire behaviour pointed to the safety of our men and guide ourselves accordingly. In this instance, the fact that this fire was going to blow up in the manner it did, was not diagnosed at the time the men were dropped."

Ninth Eastern States Conservation Conference

There was much of both general and specific interest to foresters presented at the Ninth Eastern States Conservation Conference held in Boston on August 25 and 26.

Three subjects were of outstanding interest in the field of forestry. These were papers and discussions on forest management and cutting practices, during which the Maryland and New York approaches were given fullest consideration; a progress report on the Northeastern Interstate Forest Fire Protection Compact; and discussions on forest taxation, disease and pest control.

The Northeastern Interstate Forest Fire Protection Compact created the greatest general interest. No previous compact between states has been developed with equal rapidity; the first meeting having been called by the Massachusetts Commission on Interstate Cooperation in Boston on June 4, 1948. In its final form, the compact was approved at a meeting called by the same commission on February 8, 1949, and since then it has became a law in New York and all of the New England States, excepting Rhode Island, and the President has signed Congressional approval. Rhode Island will present an enabling act in its legislature at its 1950 session.

The outstanding importance of the compact in forest protection justifies a summary of it. It represents con-

clusions reached at many meetings by interested groups and individuals in the Northeast as to how some of the interstate problems of forest fire control could best be met.

No super authority is imposed by the compact, nor does it make mandatory upon any member state, any interstate action if that action in the opinion of the state forester will be incompatible with the maintenance of adequate protection at home. Neither does the compact place any restriction or limitation upon the power of any ratifying state to provide for the prevention and suppression of forest fires within the state, nor does it prohibit the enactment of legislation or the enforcement of any state laws, rules, or regulations intended to aid in the control or prevention of forest fires. It will not modify in any manner existing or future cooperative relationships between the U. S. Forest Service and the member state.

Administered by a commission comprising three representatives from each ratifying state, the compact provides a means in an emergency quickly to secure aid in forest fire suppression by a stricken member state. It provides for closer cooperation between the states and the U. S. Forest Service in fire prevention and forest fire control under all conditions. It provides for the development of integrated forest fire plans for adequate forest fire fighting services in each state, for joint meetings of forest fire personnel for the purpose of preparing strategic forest fire control plans, and training in forest fire suppression methods. It is a vehicle by means of which cooperation so essential to efficient forest fire control may be readily extended beyond state boundaries.

It is anticipated that the three representatives from the currently member states will be appointed and an organizational meeting held early in October.

Conservation Jobs

The Virginia Commission of Game and Inland Fisheries has positions open in its Education Division for a writer on outdoor subjects, a public relations man, a wildlife photographer, and a field lecturer. Foresters with experience in these fields who wish to apply for any of these positions should write to Joseph J. Shomon, editor, Virginia Wildlife, Richmond, Va.

Reserve Engineer Forestry Battalion

A reserve engineer forestry battalion has been formed with headquarters at Birmingham, Ala., according to an announcement by the Southern Pine Association, sponsor of the unit. This is the second battalion activated under the association, the first having headquarters at Baton Rouge, La.

Latin-American Conference

The Food and Agriculture Organization has recently published a Report on the Latin-American Conference on Forestry and Forest Products held in Brazil in April 1948. Information on the utilization, protection, and development of forest resources contained in the report will be of interest to members, particularly as regards cooperation between Latin American countries and the United States.

Meeting of A.A.A.S.

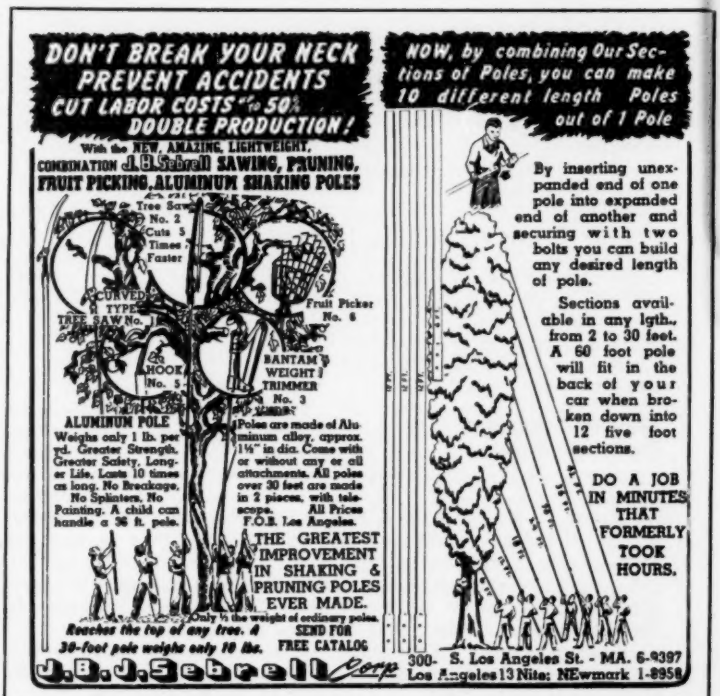
The 116th meeting of the American Association for the Advancement of Science will be held in New York City, December 26-31. All seventeen sections and subsections of the association, together with fifty-three affiliated societies, will participate in what is expected to be the largest meeting in the Association's 101-year history.

Information on the program may be obtained from R. L. Taylor, assistant administrative secretary, 1515 Massachusetts Avenue, N. W., Washington 5, D. C.

American Forestry Association Plans Interesting Meeting

Forestry and other conservation subjects will be discussed at the 68th annual meeting of the American Forestry Association, with the West Virginia Forest Council and the Ohio Forestry Association cooperating, in Wheeling, W. Va., October 10-13.

Gov. Okey L. Patterson will deliver the welcoming address at a special luncheon opening the conference. Following him will be association President A. C. Spurr, who will review the organization's work during the past year, after which the conference will hear former Governor Leslie A. Miller of Wyoming who will speak on "Conservation of Our Natural Resources—Asset or Liability?" In the afternoon, the confer-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ence will visit Oglebay Park, and that evening the Oglebay Institute will have charge of the program.

In a general discussion Tuesday morning of "Water Is Life," the participants will include former Governor Ralph Carr of Colorado; George Phillips, assistant to the secretary of agriculture; L. A. Danse, chairman of General Motors Waste Committee, and E. N. Munns, U. S. Forest Service.

Featuring the luncheon meeting will be a panel on "What Are We Seeking in Conservation?" with Edward A. Wayne, vice president of the Federal Reserve Bank of Richmond, the leader. Other speakers will be Kent Leavitt, president of the National Association of Soil Conservation Districts; Walter D. Fuller, president of the Curtis Publishing Company; Representative Robert T. Secrest of Ohio; Governor Jas. H. Duff of Pennsylvania; and William Vogt, author of *Road to Survival*.

At the evening session, Tom Gill, secretary of the Charles Lathrop Pack Foundation, will speak on "World Forestry," and Bryce C. Browning will review the work of the Muskingum Watershed Commission of Ohio.

Wednesday the conference will visit the Muskingum District, with Browning as leader. Senator Robert A. Taft will address a luncheon meeting at Lessville Lake, and that evening at the American Forestry Association banquet at the Mayflower Hotel in Akron, Secretary of Defense Louis A. Johnson will discuss, "Natural Resources in National Defense."

Thursday members of the conference will be guests of Louis Bromfield at a barbecue at Bromfield's Malabar Farm, when Governor Frank J. Lausche of Ohio will be the speaker.

Regional Logging Equipment Show

A regional logging equipment show will be held near Raleigh, N. C. on October 25 and 26. According to Dr. R. J. Preston, director of the Division of Forestry at North Carolina State College, which is sponsoring the show with the cooperation of the Forest Products Research Society and the Southeastern Forest Experiment Station, this will be the first big logging show in the Southeast.

The newest types of equipment and tools used in harvesting, milling, and transportation of lumber will be demonstrated.

Deer Repellent Tests Are Showing Promise

The West Virginia Conservation Commission reported experiments during this past summer with a new deer repellent have shown promise of answering "limited needs" in protecting orchards and crops from deer. Tests are continuing and will be expanded to include buckwheat and nursery stock.

Known as Goodrite z.i.p., the repellent was developed by the Goodrich Chemical Company which released it for public use last May.

The experiments in West Virginia so far have been confined to orchards, wildlife plantings, and cauliflower and broccoli. In further experiments its effects in repelling rabbits and mice will be tested.

The repellent nature of the chemical is in taste and not odor. In an experiment on one orchard, 810 young peach trees were sprayed. A few weeks later a check showed that four deer had recently gone through the orchard without "seriously browsing" the trees. The spray still was adhering to the plants.

Use of z.i.p., said a report from field men conducting the tests, apparently "can be economically an effective deer repellent on young orchards and garden crops such as beans that do not possess extremely waxy surfaces. In West Virginia where the deer herd is continually on the increase, crop damages are expected to mount proportionately unless management is able to keep up-to-date and cope with the new problems as they are confronted."

Weyerhaeuser Fellowships in Forest Management

Establishment of $1,000-a-year forestry fellowships at both the University of Washington and Oregon State College was announced by J. P. Weyerhaeuser, Jr., president of the Weyerhaeuser Timber company.

The grants will set up graduate research fellowships in the field of forest management, each to be known as the "Weyerhaeuser Fellowship in Forest Management."

First recipients of the fellowships will start graduate work at the beginning of the academic year in September. They will be selected by the deans of the forestry departments of the two institutions.

"The fellowships will provide opportunity for capable young men to continue their studies in problems of forest management," Weyerhaeuser said. "It is expected that the forest industry's increasing need for scientific knowledge in the management of forests and the need of deserving students for help of this nature will both be served by these fellowships."

The importance of skillful forest management in the conservation of timber resources was stressed by Mr. Weyerhaeuser in announcing the fellowship grants. Obtaining the maximum yield from forest lands on a continuous and sustained basis is of importance not only to the forest industry but to the general public as well, he pointed out.

"True conservation of our forest resources can only be achieved through improved forest management," Weyerhaeuser concluded. "We hope these fellowships will contribute toward that end."

Washington Products Institute Completes Staff Organization

Appointments to the staff of the newly organized Washington State Institute of Forest Products have been completed, Dr. O. Harry Schrader, director, announces.

Ralph DeMoisy, formerly assistant professor of forest engineering at Oregon State College, will be executive assistant to Dr. Schrader. Mr. DeMoisy will devote most of his time to the study of equipment, methods and costs of second growth salvage logging.

John Allen, formerly forester for the Nettleton Timber Company, has been appointed technologist on the staff. He is a graduate of the University of Washington College of Forestry.

Rollo England is junior technologist and Jack Kantzer and Thomas Collins are field assistants. All three are 1949 graduates of the University of Washington College of Forestry.

Prof. J. Kenneth Pearce of the University's College of Forestry was on duty during the summer months as field supervisor in planning surveys of logged-off lands. Bruce Baker, an instructor in the College of Forestry, served as a junior technologist during the summer.

The first project of the institute, a

state-wide inventory of logged-off lands, was started last summer in both eastern and western Washington. No inventory of this scope had previously been attempted in the Pacific Northwest. The inventory, which will be extended to manufacturing plants during the winter, will provide facts and figures on the amount, quality and location of usable material remaining on logged-over lands and from industrial plants of the area.

The institute, created by the state legislature, operates within the Department of Conservation and Development, with active advisory committees composed of leaders in the forest-product and lumbering industries of the state.

The primary purpose of the institute is to provide means for closer utilization of forest resources of the state, by surveys, research, and as a clearing house for information on improved methods and equipment.

Headquarters for the institute are in Anderson Hall, University of Washington, Seattle.

Bankers Take Forestry Tour

At the Bankers' Forestry Conference held at the University of Florida, July 12-13, G. G. Ware, Leesburg banker and conference chairman said, "I think that many Florida bankers now have a realization of the great assets Florida has in its timber lands, and the importance of increasing those assets."

The bankers toured the Austin Cary Memorial Forest and the Alachua county headquarters site, and university experiments in naval stores and scrub oak pulp. Representatives of the School of Forestry, the Jacksonville Branch of the Federal Reserve Bank, and students, bankers, foresters, and others attended the conference. W. A. Galloway, a Future Farmer from Vernon, told how he made $286 last year working 1,100 pine trees for gum naval stores.

Oregon Saw Chain

Oregon Saw Chain Manufacturing Corp. of Portland, Ore., makers of Oregon Saw Chain, report that the "fast-file" feature of their chain's cutting tooth is winning popularity among chain saw users.

Comment from loggers and timbermen who have equipped their power saws with Oregon Chain indicates that the fast-file tooth offers an advantage. Heretofore, saw chain filing had been a highly specialized, expensive, and time-consuming job. With Oregon Chain, the saw operator can do his filing right on the saw bar. A single full-round quarter-inch file is all that is needed to put an edge on the chain's hollow ground tooth.

Oregon Chain is available in two sizes and three standard gauges of drive link which fit all major makes of power saw. Conversion sprockets are available. The chain can be ordered for any length and make of saw bar. Information regarding dealers may be obtained through the corporation at 2712 N. Mississippi Avenue, Portland 12, Ore.

University of Florida to Operate Rangers School

Merger of the Columbia Forestry School with the University of Florida to form the first State Forest Rangers School has been announced. The former Columbia Forestry School, located in Lake City, Fla., will operate as an adjunct to the university's School of Forestry under the direction of Harold S. Newins.

Clarke Mathewson, director of the Columbia school, has been named superintendent of the newly designated Rangers School, and Eugene W. Gemmer will remain as assistant professor of forestry. The new rangers school offers a one-year vocational course in timber cruising, forest fire control, surveying, log scaling, pulp production, wood, and other related courses.

The rangers school was merged with the university by act of the legislature which made some $20,000 a year available for its operation.

P. V. Woodhead Deceased; Late Regional Forester

Philip Verne Woodhead, regional forester of the U. S. Forest Service at Albuquerque, N. Mex., died July 26.

Entering the Forest Service in 1915 as a ranger, he worked on land classification and timber sales, and successively became deputy supervisor, supervisor, assistant regional forester, and regional forester. Most of his career was spent on western national forests, particularly in the Rocky Mountains.

Although not a forestry school graduate, he was a keen student of forestry subjects and his work was

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uniformly of high order. He was elected a Junior Member of the Society in 1923, and a full Member in 1930.

Michigan Land Classified

Classification of 438,459 acres of state land in 47 northern Michigan counties, with nearly half or 210,843 acres allotted for public conservation uses, completes over three years of special dedication work by the Conservation Department's Lands Division.

Working with county land-use planning committees on the classification study since 1946, the department considered soil character, topography, forest growth, past and present uses, and location before making recommendations to place nearly half of the acreage in state forests primarily, but also in state parks and public fishing sites.

Not involved in the classification study were the other 36 counties in southern Michigan. Tax-reverted lands in this part of the state came under the now defunct State Land Office Board whose sole function was to get these lands back into private ownership quickly and without regard to best uses. With the Conservation Department taking over administration of southern Michigan tax-reverted acreage, May 1, these lands in the future will be classified as to best usage before disposal recommendations are made.

Chamber of Commerce Policies on Natural Resources

Policy Declaration on Natural Resources is a recent publication of the Chamber of Commerce of the United States.

Copies may be obtained from the Natural Resources Department of that organization, Washington 6, D. C.

Blister Rust Disease

The Wisconsin Conservation Department is trying to produce a strain of white pine that will be resistant to blister rust disease. A progress report has been made by Professor A. J. Riker of the University of Wisconsin stating that an occasional plant is found to be resistant to the disease. Such plants are used for propagation and it is hoped that eventually resistant trees may be produced in practical quantities for use in the state.

Joseph Davis Retired from Los Angeles County Service

Joseph J. Davis, chief assistant forester and fire warden of Los Angeles County (Calif.), recently retired after 27 years of service.

Joseph J. Davis

He and Spence D. Turner, county forester and fire warden, began the organization of the county's fire districts in 1924. The department now operates 42 stations and employs numerous foresters and other technicians.

Born July 9, 1889 in Denver, Colo., Mr. Davis studied civil engineering, and took forestry courses at the University of California at Los Angeles. He joined the Los Angeles County Forestry Department in 1922, following service in the Army during the first world war.

He made one of the early studies of the use of chemicals in forest fire control, and was co-author of an article on that subject in the JOURNAL OF FORESTRY. In addition, he pioneered in the development of mobile fire fighting tank trucks and in the application of radio communications to fire control.

Dutch Reforestation Aided by American Firs

The Douglas-fir, transplanted from Oregon to The Netherlands to reforest partially denuded forest sections of the country, is doing well in Dutch soil.

Some of these trees were planted eighteen years ago in central Holland, in a section that for centuries, much of it since the ninth century, seemed suitable exclusively for broadleafed trees.

To save what is left of the old Dutch forests and to develop denuded areas into new forests, both for utilitarian and for recreational purposes, is the aim of the forestry service. It started rather late, after many private owners had sold their trees, for profit, in the latter part of the nineteenth century. Several laws were passed to prevent further denuding. At present only 8 percent of Holland's total surface is wooded. This makes her the forest-poorest country in Europe, except England.

The Forestry Service, now celebrating its fiftieth anniversary, controls some 160,000 acres. Besides, the law for the preservation of natural beauty, passed in 1928, gives the department control also of some 250,000 acres of private grounds, which the owners can no longer convert to other purposes without special permit.

Many of the larger cities are cooperating with the government to bring new woods into being. In Amsterdam, for example, a new woods has been created which when completed may become the largest artificial forest created anywhere in Europe.

Georgia Leads South in Pulpwood Production

Georgia produced more pulpwood during 1948 than any other state in the South.

The state's total production last year was 1,770,600 standard cords, an all-time record.

POSITION WANTED

Forester, 28, married, 2½ years' federal and private experience in stand improvement, cruising, logging, planting, some research, seeks change to private industry. Prefer northern half of U. S. Data sent on request. **Box L, Journal of Forestry, Mills Building, Washington, D. C.**

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Correct Price
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Norway Spruce, Red Pine, White Pine, Scotch Pine, White Spruce, Colorado Blue Spruce, etc. Prices are reasonable and the trees are GUARANTEED TO LIVE.
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Forestry Department Closed

The Forestry Department of Harbor Plywood Corporation, Portland, Ore., of which Fred H. Brundage was head, has been discontinued. He will continue with the company on a half-time basis.

John R. Bruckart, Jr., formerly in the department, is now assistant logging superintendent of the Lewis River Logging Company.

Booklet Lists Free School Forestry Publications

A new 16-page booklet listing forestry materials available without charge for classroom use is now being distributed to schools in all states.

The bibliography, *Forests, Their Use and Conservation*, eventually will be sent to more than 100,000 school and college officials.

Copies of the bibliography may be obtained free of charge from the American Forest Products Industries, Inc., 1319 18th Street, N. W., Washington 6, D. C.

Permission Signs Effective

Numerous Missouri farmers have decided after several years trial that "Hunting by Permission Only" signs were the most effective type to control game harvest on their farms.

In operation, a wildlife program is usually carried on jointly by interested sportsmen and the landowners. The hunter, 4-H Clubs, or other conservation groups provide signs and help the farmer plan and carry out means of improving game food, cover, and water. The farmer does not allow unsportsmanlike hunters to trespass. He benefits doubly from the program because good wildlife measures generally contribute to his farming enterprise and, too, his own hunting success is increased.

Weber Retires as Lab Editor

Wallace W. Weber laid aside his editorial pencils in July to do some hunting and fishing out California way—thus signaling his retirement as chief of the division of Information and Education at the U. S. Forest Products Laboratory at Madison.

Weber, who has directed the publication and distribution of the laboratory's research results since 1943, has rounded out a quarter-century on the staff since going to Madison in 1923. Shortly after graduating from the University of Michigan in 1912, he was successively ranger, forest assistant, deputy supervisor, and supervisor of national forests in Oregon, Idaho, and Montana.

Succeeding Weber as I&E chief at the laboratory, announced Director George M. Hunt, is Donald G. Coleman, staff editor for the past 21 years.

Palmettos Used for Furniture

Florida's cabbage palmettos may soon have another use besides beautifying the state's nature trails and providing "swamp cabbage" for her citizens' dinner tables.

The development of a chemical treatment that will dry, harden, and make the frond of the cabbage palmetto suitable for use in furniture making by G. D. Fortman, 2301 Westwood Avenue, Tampa, may prove the tree to have a new important commercial use.

In fact, Fortman has built several pieces of living-room furniture from the cabbage palmetto, using his secret chemical treatment. If public reaction is favorable to his palm furniture, Fortman plans to establish a manufacturing plant for his product in Tampa.

Use of Tall Oil Increases

According to a report by the U. S. Bureau of Agricultural Economics, use of tall oil, fatty acids, and other secondary fatty materials in drying-oil products continued to increase in 1948, though at a slower rate than formerly.

Over 80,000,000 pounds of these products were utilized during 1948, as compared with 75,000,000 in 1947, and 54,000,000 pounds in 1946, the report shows.

Exports continued to be an important outlet for tall oil, amounting to 37,000,000 pounds in 1948, compared with 30,000,000 the previous year. Paints, varnishes, linoleum, and oil cloth took 18 percent of domestic disappearance of tall oil last year, with a similar proportion in 1947.

Forest Fire Committee

J. A. Hall, director of the Pacific Northwest Forest and Range Experiment Station, has reported that the first meeting of the station's forest fire research advisory committee was held in Portland on July 28. In attendance were specialists in fire control from the U. S. Forest Service, state forest services, and private industry in the Northwest, together with A. A. Brown, chief of the Division of Fire Control Research, Forest Service, Washington, D. C.

The principal aim of the committee is to provide plans for fire research to meet existing needs and provide future programs for research.

Similar committees are being selected in other parts of the West.

Farm Forestry Short Course

A special short course on the improved processing of farm timber, sponsored by the College of Agriculture of the University of Wisconsin, will be held at Madison, Wis. on

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TWIN BLADES TURN IN OPPOSITE DIRECTIONS
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October 11-13. The objective of the course is to show practical methods for improving the quality and expanding the market for such lumber. Any sawmill operator or processor of lumber products may attend the course.

References on Conservation Available

The National Committee on Policies in Conservation Education has issued a list of selected references on conservation for pupils and teachers. Copies of this list, which will be of interest to foresters in all phases of educational work, may be obtained from John W. Scott, chairman, 1409 Garfield Street, Laramie, Wyo., at a cost of five cents.

W. J. Morrill (1875-1949)

Walter J. Morrill, former professor of forestry at Colorado A & M College, died in Fort Collins, Colo., August 24.

Born April 17, 1875 at Madison, Maine, he obtained the B.S. degree at the University of Maine in 1899 and the M.F. degree at Yale in 1905.

Entering the U. S. Forest Service in 1905 as the result of having passed the forest assistant examination, he was assigned to national forest administration in Colorado, and rose through grades to the position of supervisor. After a brief period in the Washington, D. C. office as assistant editor, he headed the forestry department of the University of Nebraska for three years during the period 1912-1915.

In 1915 he was appointed professor of forestry at Colorado State College and ex officio state forester, serving in the latter capacity until 1933 when the duties of state forester were divorced from the professorship and assigned to the supervision of the Board of Land Commissioners.

Prof. Morrill continued active teaching in the College until his retirement in 1940 at the age of 65 after a quarter-century of service.

During his long and useful career, Prof. Morrill was the author of numerous popular and technical articles on forestry. He was chairman for two years of the Central Rocky Mountain Section of the Society.

He was buried in Parkersburg, W. Va. where Mrs. Morrill can be reached at 216 13th Street.

R. C. Fraunberger Promoted by Philco Corporation

The Philco Corporation and its subsidiary, Southeastern Industries, Inc., have announced the appointment of R. C. Fraunberger as vice president and general manager of Southeastern. Mr. Fraunberger has been Southeastern's general manager and manager of Philco's Forest Products Division since March 1946.

Fabian Bachrach
R. C. Fraunberger

Graduating in forestry from the University of Michigan in 1935, he worked for several years with the U. S. Forest Service. He left the Forest Service to attend the University of Chicago School of Business, and then was employed by Northwestern Veneer and Plywood Corp., a subsidiary of Atlas Plywood Corporation, in northern Michigan. Later he was made manager of Atlas Plywood Corporation's plant at Munising, Mich. In 1943 he volunteered for naval service and, after a tour of sea duty as a gunnery officer, was appointed officer-in-charge, Industrial Engineering, Container's Division, Navy Bureau of Supplies and Accounts, Washington, D. C. When placed on inactive duty he joined Philco, and organized Southeastern Industries Inc.

Southeastern has headquarters in Philadelphia, but owns timberlands in the Southeast, operating a branch office, band mill, and planing mill at Conway, S. C. Producing hardwoods, tidewater red cypress, and pine, it has enough timber for a long life. The upper grades of the best hardwoods are used by Philco in its radio cabinet plants, but the bulk of the lumber is sold on the open market.

White Pine Book

The Western Pine Association has recently published an attractive book of 64 pages, beautifully illustrated, on *Idaho White Pine, Its Properties, Uses, and Grades*. This book is the fourth in a series which includes white fir, larch, and Douglas-fir. The book is of general interest, not only to foresters, but to anyone who wishes to know of the many uses of the wood.

Nature Guiding Commemorated

The start of the Nature Guiding program in the national parks of our country is recalled by a bronze plaque which has been dedicated at Fallen Leaf Lake, California, in honor of W. W. Price, of Palo Alto, who launched this movement there in midsummer, 1919.

When W. W. Price, who was a biology graduate of Stanford University, learned of the nature guiding movement carried over from Europe by Mr. and Mrs. C. M. Goethe of Sacramento, he induced a group of proprietors of Lake Tahoe resorts to participate in the interpretive program. Stephen T. Mather, at that time director of the National Park Service, observed the value and popularity of the nature guiding at Fallen Leaf and requested its introduction into Yosemite in 1920.

This was the beginning of the national parks ranger-naturalist interpretive program. Newton B. Drury, present director of the National Park Service, says, "The nature interpretation program, of which W. W. Price was a pioneer with Mr. and Mrs. C. M. Goethe and Stephen T. Mather, has assumed great importance in the National Park System."

In the California State Parks, including the extensive redwood parks, nature guiding has been developed in recent years, along the lines set in 1919 at Fallen Leaf Lake by the original staff of scientists, Dr. Harold C. Bryant and Dr. Loye Miller.

The bronze plaque is set on a half-ton boulder facing Fallen Leaf Lake, with Cathedral Peak in the background.

Southern States Set Reforestation Record

In a remarkable expansion of reforestation of old fields and idle forest lands in 12 southern states during the past winter and spring planting season, industry played an outstanding part according to a survey released by the Southern Pine Association of New Orleans.

State forestry departments produced and distributed from 19 state-operated nurseries nearly 155 million forest tree seedlings. Private industry purchased for planting on company lands and for free distribution to small landowners 82 million seedlings—53 percent of the total state nursery production in the 1948-1949 planting season. According to state foresters' reports of seedlings purchased, the pulp and paper industry accounted for 26 percent, the lumber industry 16 percent, and all other industries 11 percent of total industry purchases. Approximately 80,000 acres of industry owned lands were reforested while over 9,000,000 forest tree seedlings were distributed free to small landowners by the lumber and pulp and paper industries.

States covered in the survey included Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

South Carolina led all southern states for the 1948-1949 season with 32 million seedlings. Georgia ranked second with 27 million and Alabama and Florida ran a close third and fourth place with some 19 million each.

State foresters' estimates of production at 20 nurseries during this year indicate an even larger reforestation program during the coming planting season. The 1949-1950 production figures indicate that more than 234 million seedlings will be available for distribution to landowners from state nurseries.

Personals

Richard E. DeCamp, chief forester for the Willamette Valley Lumber Company, died following a heart attack while on a cruising trip. Mr. DeCamp, a graduate of Oregon State College, was a Member of the Society.

The U. S. Forest Service has announced the promotion of Avon Denham to assistant chief of the Division of Range Management in Washington, D. C. Mr. Denham has been assistant in range management of the California Region of the Forest Service since 1944. He is a graduate of the Colorado State College of Agriculture where he received his bachelor's degree in forestry in 1928. He is a Member of the Society.

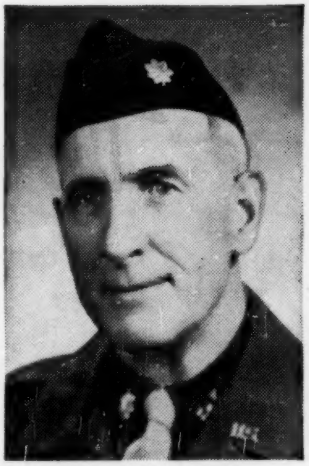
Jack B. Dodd has been transferred from Region Four of the National Park Service, San Francisco, to the office of the director in Washington, D. C. He will serve on the staff of Chief Forester John D. Coffman. Mr. Dodd has been employed as a forester with the National Park Service since his graduation from the School of Forestry of the University of Idaho in 1932, except for a short time on the Chippewa National Forest and four years in the Army during World War II, from which he emerged with the rank of major.

Arthur E. Lindholm, forester on the Mio District of the Lower Michigan National Forest, died in an airplane crash on July 16. Mr. Lindholm, a Junior Member of the Society, received his M.F. from the University of Minnesota in 1949.

Charles R. French, formerly managing director of the American Forest Products Industries, died August 16 of a heart attack. Mr. French has been in public relations work in the lumber industry for many years. For thirteen years he was employed by the National Lumber Manufacturers Association, then served for four years with AFPI, resigning in 1945 to organize his own public relations firm in New York.

Several months before his death he had been called to Washington to work on a special assignment with the National Securities Resources Board.

Marvin E. Smith, a Junior Member of the Society and a graduate of the University of Minnesota, has been appointed assistant extension forester at that University. Mr. Smith was formerly employed by the Tennessee Valley Authority.



William James O'Neil

W. J. O'Neil of the U. S. Forest Service, Harrisburg, Ill., has been elected governor of the 216th district of the Rotary International. Mr. O'Neil, a Junior Member of the Society, was graduated in logging engineering from Oregon State College in 1917. After serving as a lieutenant in World War I, he entered the forestry profession and has worked in forestry since that time, except for two years during World War II when he attained the rank of major in the Corps of Engineers.

Arthur T. Upson has moved to Berkeley, Calif. where he will do special forest utilization work at the California Forest Experiment Station. Mr. Upson, a Member of the Society since 1914, had been director of the tropical region of the U. S. Forest Service since 1943 with headquarters in Puerto Rico.

The new director is Henry B. Bosworth, formerly supervisor of the Texas National Forests, who has had long experience in federal forestry work.

Bill H. Wilford, formerly of New Jersey, has been transferred to the Fort Collins, Colo. station of the Bureau of Entomology and Plant Quarantine to work on forest entomological surveys and research. Dr. Wilford, a Member of the Society, took his undergraduate work at Pennsylvania State College, received his M.F. at Yale, and was awarded the doctorate at the University of Michigan in 1930.

The year that got away—

LONG AGO, he'd planned the year, the day, the hour of his retirement.

But now, a year beyond that date, his desk is still open . . . the weekday trout still in the brook.

What happened? Unexpected expenses . . . Nickie starting college . . . the last of Mom's hospital bills. He never really figured it out. But the happy day he planned was no longer in sight.

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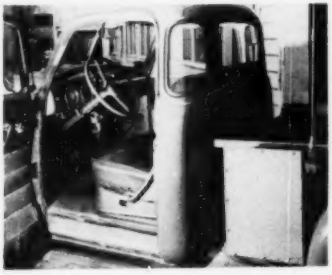

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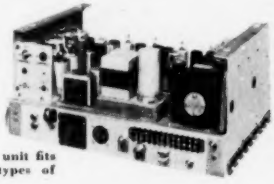

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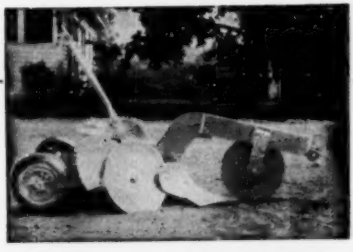

STOP THAT FIRE
Ranger Pal Fire Plow

The "Ranger Pal" is a hand mechanically operated middle-buster with coulter, plow. Drawbar connection has three elevation heights, built of 1" steel. An 18" coulter is mounted ahead of middle-buster and will cut a 4" root. One 20" harrow disc is mounted on a "wing" to each side of middle-buster turning the sod over and out. Two 8-inch wheels, complete with 4.00-8 tires are independently suspended for stump clearance, and may be retracted through 90 degrees from true vertical (down) to horizontal (aft), by a ratcheted hand lever atop plow. The action of lever on wheels effects depth of plowed line and when in stowed position allows plow blades at least 3" clearance over ground. Plow leaves a 6-foot raw earth line and may be pulled by any light Cletrac HD-5 or similar tractor. Satisfied users will acclaim effectiveness. Mass production price at $450.00 each, f.o.b. shop. Fully guaranteed.

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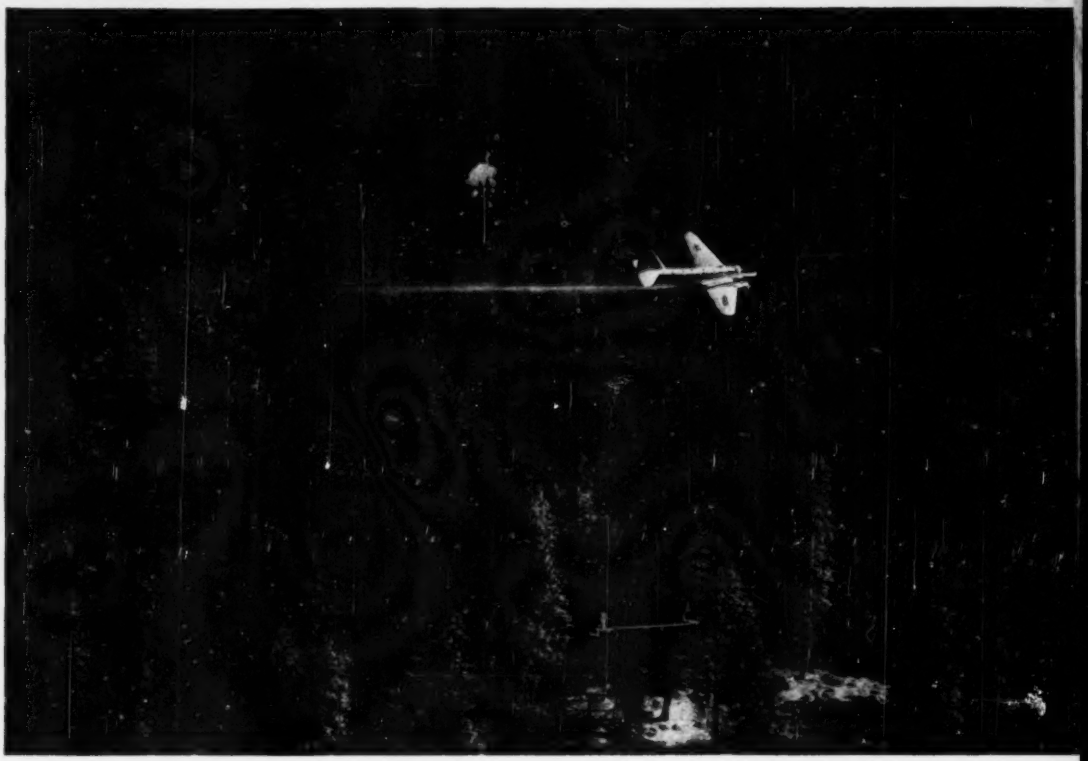

Saving the crop that makes our pulp and paper

Timber, like corn, is a crop. Timber must be nurtured and protected if the industries it supplies are to prosper and the public is to get good products at reasonable prices. The leaders in the timber business are scientific forest farmers with a long range growing program, an important part of which is the protection of the forests from devastating insects.

Among the insect enemies of the coniferous timber crop, the spruce budworm is most destructive.

This spring, private interests joined with federal and state control authorities in a large scale attack on the spruce budworm in the Northwest. Pennsalt was called on for an insecticide to be sprayed from aircraft. A new DDT compound, a Penco forest insect spray, was quickly produced at Pennsalt's Portland plant. When sprayed over 260,000 acres of Oregon spruce and fir, it killed 97% of the spruce budworm larvae.

Pennsalt will continue to apply its long experience with food crop insecticides, to the problem of protecting our forests from insect damage. Pennsalt also supplies effective herbicides to keep down the undergrowth which blocks forest roads.

These products for the timber grower are another contribution to the pulp and paper industry to which Pennsalt has been a supplier of caustic soda and chlorine for many years. All these products are made in the Northwest from Northwest raw materials and with Northwest power.

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